A window open on the world

The UNESCO Courier

March 1965
(18th year)
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teaching machines

UNESCO ARCHIVES

1965: International Co-operation Year

"WE live in a world of conflicts and yet the world goes on, undoubtedly because of the co-operation of nations and individuals... Little is known, or little is said, about this co-operation that is going on, but a great deal is said about every point of conflict, and so the world is full of this idea that the conflicts go on and we live on the verge of disaster. Perhaps it would be a truer picture if the co-operation elements in the world today were put forward and we were made to think that the world depends on co-operation and not on conflict."

In these words, addressed to the United Nations General Assembly, Jawaharlal Nehru, the late Prime Minister of India, drew the attention of the world community to the relative silence on the immense amount of co-operative work that goes on between countries in contrast to the emphasis that is placed on conflict in the world.

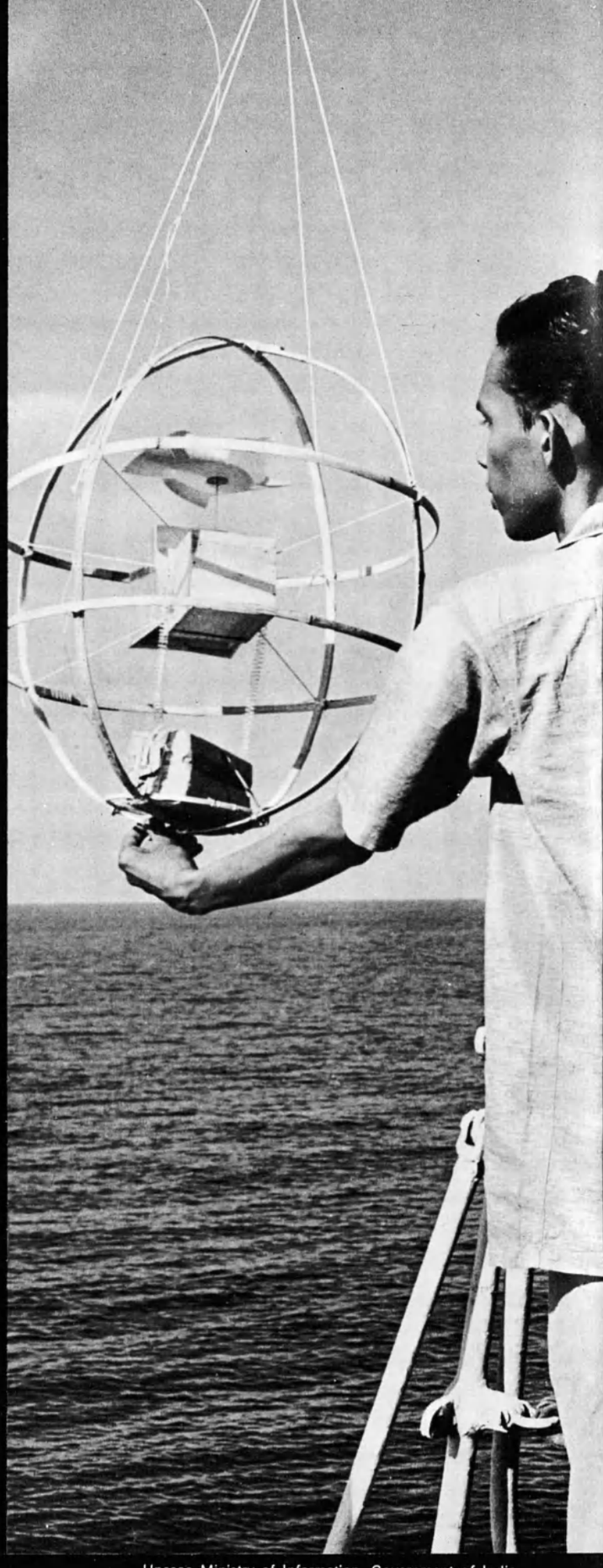
Mr. Nehru recalled a suggestion that the U.N. General Assembly should ask all countries to devote a year "not to speeches about peace", but to the furtherance of co-operative activities in all fields. The dedication of such a year, he believed, might direct man's thinking and energy to the idea of co-operation, and thus create an atmosphere for solving problems more easily and lessen the world's conflicts.

On December 19, 1962 the U.N. General Assembly unanimously adopted the idea of an International Co-operation Year and on November 21, 1963, it designated 1965, the 20th anniversary of the United Nations, as International Co-operation Year.

THE Year will be commemorated under the symbol of joined hands and with the theme "Peace and Progress through Co-operation". Stamps issued by the U.N. Postal Administration and a special medallion will commemorate jointly the U.N. Anniversary and the International Co-operation Year.

U.N. Specialized Agencies, the International Atomic Energy Agency, non-governmental organizations and U.N. member states have been asked to link their own special interests and activities with commemoration plans for this year of co-operation. Member states have been asked to consider ratifying a number of multilateral agreements which have as yet been applied only on a limited scale, particularly those relating to the Law of the Sea and to Human Rights and related fields.

The Year of International Co-operation will have attained its goal if it leads a greater number of the world's peoples to concern themselves more directly with the problems of international co-operation, as well as its achievements, its hopes and its potentialities.



Unesco-Ministry of Information, Government of India

The work of the World Meteorological Organization is one of the longest-established examples of effective world-wide co-operation. This specialized agency of the United Nations grew out of the International Meteorological Organization, an organization of national weather services created nearly 90 years ago. In the U.N. calendar for International Co-operation Year, March 23 has been designated as World Meteorological Day. Here, a meteorological observation balloon with transmitter is released from a research vessel.

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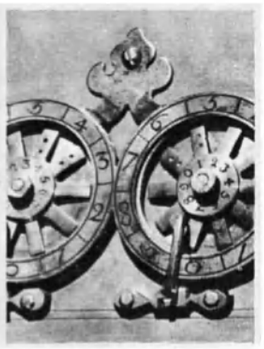

COVER PHOTO

Detail of operating wheels on the world's first calculating machine devised by Blaise Pascal in 1642. Other inventors later improved on Pascal's system, but it was not completely replaced until 1946 in the era of the electronic computer (see page 15).

Michel Péron, Paris

Page

2 1965 : INTERNATIONAL CO-OPERATION YEAR

4 THE INTERNATIONAL PROSPECTS OF SCIENCE
By Noraïr M. Sissakian

8 EDUCATIONAL PROGRESS AROUND THE WORLD

10 TEACHING MACHINES
Can they solve some major educational problems?
By Ted Morello

17 SCIENCE AND THE COMMON MAN (Part two)
By Ritchie Calder

18 THE INVENTIVE GENIUS OF LEONARDO DA VINCI
Models of the earliest automobile, aeroplane, helicopter

24 GENEVA : WORLD H.Q. AGAINST SMALLPOX

28 EDWARD JENNER, THE FATHER OF VACCINATION

33 LETTERS TO THE EDITOR

34 UNESCO'S WORLD PROGRAMME FOR 1965-66

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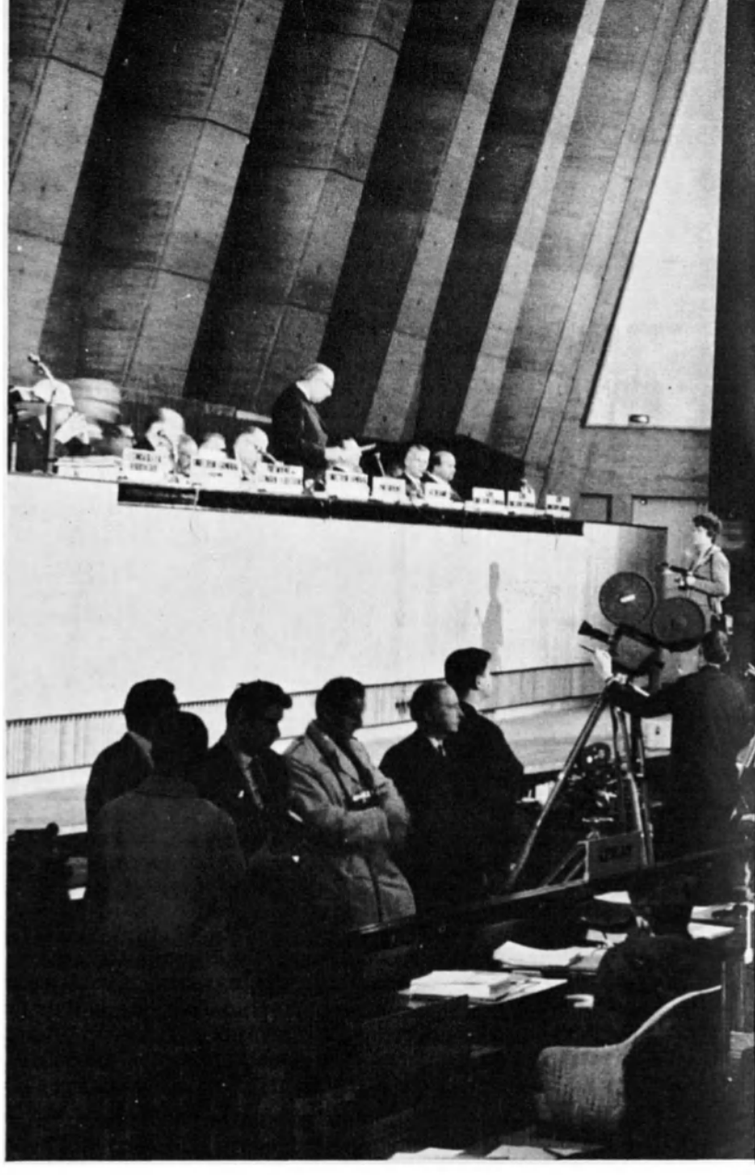
UNESCO ARCHIVES

Few people are unaware today that the scientific explosion is transforming our basic patterns of living, but precisely how it has done so and the important role of fundamental research are still far too often misunderstood. In Unesco's programme science has now been given priority on an equal footing with education (see page 34). This was reflected last year when a world-renowned scientist was elected President of the 13th Session of the Unesco General Conference. He was Prof. N.M. Sissakian, principal scientific secretary of the Praesdium of the Academy of Sciences of the U.S.S.R. and a world authority on space biology. Last year he was elected a member of the International Academy of Astronautics. Below we publish an abbreviated version of the address he delivered following his election to the distinguished world post.



Unesco's General Conference in session in the main hall at Unesco's H.Q. in Paris.

Unesco - R. Lesage

THE INTERNATIONAL PROS

IN the history of civilization, science has always been a force for progress. Today, under new social conditions, it is becoming a directly productive force. Every human activity is closely bound up in one way or another with the utilization of the achievements of science and technology.

Thus, two problems take on major importance: the extension of theoretical, fundamental research in such branches of science as physics, chemistry and biology; and the application of science to production.

After Galvani made his famous discovery of electric phenomena in living organisms, several decades went by before the appearance of the first electric lamp. Today, any important discovery very quickly reaches the production stage, outstripping the most optimistic hopes of its inventors.

Every one knows that the development of mathematics determined the growth of mathematical logic and cybernetics which, in conjuction with the achievements in electronics, led to the manufacture of computers and automatic-control machines that play so important and vital a part both in science and technology. Achievements in theoretical and experimental physics gave man mastery over the nuclear energy of the atom, and are now helping him to gain control over thermonuclear processes so that they can be used as a mighty and practically inexhaustible source of peaceful energy.

Achievements in modern science ushered in the era of the exploration of the cosmos with the aid of artificial sputniks, rockets and spaceships, and led to the creation of the indispensable basis for a deeper knowledge of the natural phenomena of the universe, bringing, as it were, the planets of the solar system nearer to our planet. The development of modern biology, biophysics and microbiology provided the basis for the development of branches of industry concerned with antibiotics, vitamins, ferments and pharmaceutics, all of which are vitally important to human life. Thus, theoretical research conditions practical scientific achievement, makes possible technical progress and can sometimes lead to the creation of new branches of knowledge and of production.

While economic independence is essential to the achievement of full political independence, economic progress is unthinkable without the development of natural and applied sciences in every country and without the rapid translation of results into practice. The investigation of nature's regular patterns, the discovery of new laws which increase

PECTS OF SCIENCE

by Noraïr M. Sissakian

man's control over spontaneous natural phenomena, so that he can utilize natural resources more rationally and enrich them—all this is the task of the natural sciences. Knowledge of natural resources is especially important for the developing countries which are now becoming industrialized and transforming their agriculture.

The development of chemistry has become absolutely indispensable. This science enables man to produce more and better clothes, to create new materials which are stronger and more efficient than natural materials, to preserve food and to eat better. We have all become aware in recent years of the growing importance of developing the chemistry of natural compounds, together with the study of the mechanism of biochemical synthesis and the investigation of the biological effects on the soil of the chemicals used to control plant and animal diseases.

It is at present impossible to maintain high livestock productivity and high yields in agriculture unless chemicals are used. On the other hand, the indiscriminate use of chemicals is fraught with danger for the health of men and animals. That is why problems of soil biology, biochemistry and cell biology are so important and must be investigated.

New technical principles involving the widespread application of the laws of living nature have emerged, as, for example, in problems concerning reliability in technology or in increasing the efficiency of mechanisms and technological systems. At this level, complex interdisciplinary study of the brain takes on a special importance.

The close links between science and education and the growing role of science in our modern society have led Unesco to accord a priority to science in its programme similar to that already given to education. It is impossible to speak of the effectiveness of education if its results are not incorporated in technical and scientific projects and do not lead to the solution of technical and scientific problems. In turn, the effectiveness of education is determined by scientific and technical achievement.

Certain fears have been voiced in the past—and unfortunately are still being reiterated by some people—that our planet's sources of energy are being rapidly exhausted and that we shall be unable to feed an increasingly vast population. Present-day achievements in the natural sciences and in technology have answered these fears and show that all grounds for pessimism are unfounded.

As I have said, recent discoveries in physics have

CONT'D ON NEXT PAGE

An assessment of world needs and resources

opened the way to controlling thermonuclear reactions. A solution to this problem would fully satisfy the power requirements of all mankind and for all time. As to our capacity to provide adequate food supplies for the entire population of the world, the following figures can be quoted. The total surface area of arable land, plantations and orchards in the world amounts to 1,400 million hectares, while pastureland covers 2,600 million hectares, i. e. only 11 to 12 per cent of the total land area. Let us assume that these figures remain unchanged until the end of the 20th century. By this time overall yields will have risen to the level already reached in many countries of the world: three tons per hectare of arable land and one ton per hectare of pastureland. Even if we base our calculations on these minimum figures, total production by the end of the 20th century will amount to 7,000 million tons of standard cereal units. This is sufficient to feed twice the population which will inhabit the earth by the end of the century, according to United Nations estimates.

THESE calculations do not include food resources of the oceans and seas where the major part of the organic matter formed on the earth is found. However, so far the biological and mineral resources of the oceans have only been sporadically exploited. It is only natural that the rapidly increasing population of the earth should want to use them to the fullest extent. This has now become possible thanks to the rapid progress of science and different technological developments. A recent French film, "Le monde sans soleil" (World Without Sun) gives a good idea of the wealth of resources in sea and ocean and of the peculiarities, variety and beauty of marine life.

The biological riches of the oceans are mainly food resources. They are a source of proteins—the most frequently deficient item in diets. They are also a valuable food supply for birds and animals, and an essential element in a variety of technological processes. According to the most conservative estimates, the world catch of marine food products will reach 50 million tons in the near future. But this is not a ceiling. The figure can be raised in the near future to 100 million tons a year. The experience of Peru, which in the last ten years has increased 200-fold the fishing haul in the central part of its Pacific seaboard, is a striking pointer to future prospects.

A knowledge of the laws governing production of organic substances by marine organisms is essential if we are to make use of the rich biological resources of the ocean and increase productivity. Without this knowledge it is impossible to project fishing standards or to develop new strains or new fishing grounds.

The chemical and mineral resources of the ocean are inexhaustible. Almost all the known chemical elements in the Mendeleyev's Periodic Table occur in sea water or on the ocean bed. So far, because of existing traditions in economics and technology, it is mainly cooking salt, bromine, magnesium and calcium that have been extracted from sea water. And yet, reserves of iron and manganese in the sea and the ocean amount to 200 thousand million tons, while oil and gas reserves on the sea-bed are comparable with continental deposits, and may even exceed them.

The study of seas and oceans and the exploitation of their mineral and food resources raise many national and international problems. They will have to be solved if the fishing industry is to be developed, useful species acclimatized, useless and harmful organisms removed and the industry diverted from one species to another and from area to area, in order to preserve ocean resources from exhaustion and create a stable source of raw materials. Unesco must play an ever-increasing role in solving these problems.

In another sector, the demineralization of sea water opens up broad prospects for the satisfaction of mankind's growing demand for fresh water. Not so long ago there was no shortage of water over the greater part of the world. At present the demand for fresh water has grown, and is continuing to grow, to such an extent that the problem of a water "famine" has arisen.

The provision of public water supplies for expanding towns and rural communities goes hand in hand with an increase in individual consumption. Agriculture, for reliable harvests, needs irrigation, which demands ever increasing quantities of water. Industry, and particularly the chemical industry, uses tremendous amounts. This is why the question of the quality of water and the distillation of sea water are now among the most important scientific and technical problems of our time.

To solve these problems, the use of atomic energy is of the greatest importance. The demineralization of sea water through international co-operation and research by scientists from many countries is one of the main goals in the application of atomic energy to peaceful uses. Atomic energy should cease to be a potential weapon capable of destroying man's material wealth and cultural treasures; it should be made the means of turning deserts into gardens and of meeting man's increasing needs for fresh water.

But the demineralization of sea water is still not in everyday use. The collection and rational use of existing freshwater supplies are thus of far-reaching importance. One example of the successful solution of this problem is the construction of the Aswan High Dam with the prospects it offers for the agricultural and industrial use of water and for cheap water power.

PROBLEMS of water supply are complicated not only by the fact that water is required in greater quantities than ever before, but also because man replaces much of the water he draws from his reserves by contaminated waters, the majority of which are toxic even in the weakest solutions.

Because of this toxicity, particular forms of fauna and flora are destroyed, their reproductive process is damaged, their fertility reduced and the quality of their progeny lowered. Owing to the testing of nuclear weapons, various radioactive substances fall into reservoirs. The peoples of the entire world must achieve a complete cessation of all types of tests of atomic weapons. The struggle for a clean atmosphere, hydrosphere and biosphere therefore becomes a task of prime importance.

According to a report by the World Health Organization, waterborne diseases, including typhoid, dysentery and cholera, strike down five hundred million people every year and cause the death of five million babies. In this connexion it was decided at the most recent World Health Assembly to take steps to expedite the preparation of national programmes for ensuring that drinking water is safe to use.

But the elimination of infectious diseases depends not

CONT'D ON PAGE 8

Unesco-Australian Commonwealth Film Unit

Aboard an oceanographic research ship in an expedition sponsored by Unesco, a crew member takes samples taken from the sea for laboratory analysis. In 1959 Unesco sponsored an expedition to the Indian Ocean, joined by 24 countries. This survey will continue until the end of 1965. In 1963 Unesco launched a seven-country expedition in the tropical Atlantic Ocean.

only on the protection of water from contamination, but also on a profound understanding of the biochemical and physiological processes which take place in the cell, and the organism as a whole. In this connexion, the co-ordination of activities between the various organizations in the United Nations system and the international non-governmental organizations is of growing importance.

There is a vast and rapidly developing scientific field where international collaboration is particularly needed: the earth sciences. Today, geophysicists are agreed that it is quite impossible to grasp the laws governing the development of the earth's crust by carrying out observations, however thorough, in a single region. Only synchronized and uniform observations throughout the world, only the study of every object and every process, using all the available methods and technical means, can substantially further man's understanding of the nature of the processes taking place in the earth's crust. It is particularly important to plan ways in which man may master these tremendous forces, these processes that unleash energy far surpassing anything we have produced artificially, and subordinate them to his will.

International scientific co-operation, successfully initiated on an unprecedented scale during the International Geophysical Year and since continued through new international projects, should therefore aim not only at conducting research in certain countries but also at applying the results of this research to improve living conditions for all peoples.

IT is no mere chance that Unesco has been called upon to play a leading role here. Unesco's support of such international projects in the earth sciences as the international project for the study of the upper mantle, international oceanography research, the International Years of the Quiet Sun and the programme for the study of icebergs, earthquakes and volcanoes, will help not only to make possible scientific observations that build up the over all picture, but also to organize such observations in developing countries. The creation of suitable observatories, laboratories and services will lead both to the general progress of science in these countries and to the discovery of new natural resources. Foundations will be laid for an active harnessing of nature that can be effective only if undertaken on a world-wide scale.

Unesco's action under its seismological programme has become particularly important. An overall picture of progress in seismological research and in anti-seismic construction has been obtained through missions carried out in many earthquake-prone countries. With the knowledge thus obtained it should be possible to solve the most urgent problems of regions where the danger of earth tremors is greatest. The mapping of danger zones and the adoption of special measures, protective and constructional, will save human lives and prevent costly damage. There is every reason to hope for fruitful results from international co-operation in this field.

The significance of education is best exemplified by the popular saying that an illiterate man cannot see even from a mountain top. Education is of the greatest economic and social importance especially nowadays when the harmonious development of man's mental and physical faculties must satisfy the needs of all sections of society, serving as an essential basis for continued progress. As for problems in the field of public education, every aspect of these economic repercussions must be studied. One example we may quote is the work of S.G. Strumilin, a member of the Soviet Academy, who has attempted to assess the economic consequences of the development of education. Prof. Strumlin has reached the following conclusion: the value of the work done by a person who has had four year's primary education is 43 % greater than that of an illiterate person, 108 % greater if he has had a secondary school education and 300 % times greater if he had a higher education. Taking these figures as a basis for calculation,

CONT'D ON PAGE 32

Educational around

Reviewing Unesco's present work and future plans, the Unesco General Conference heard the views of 94 speakers, forty-seven of them Ministers of Education. In discussions on the world's educational problems delegates reported on developments in their own countries. Here we present a few educational highlights from these discussions. For other news of the Unesco General Conference see page 34.

Costa Rica

Educátion has always been given a high priority in Costa Rica—where the two first presidents were schoolteachers and primary education has been free since 1869. In 13 years (1950-63) Costa Rica increased school attendance in the 7-12 age group by 21% (to 88%). Today more than half the country's population aged under 25 attend schools or universities.

Republic of Korea

Ninety-five per cent of primary school age children (about five million) attend classes. To meet classroom shortages, some classes are organized in two or three shifts. Korea has a high literacy rate (about 90%).

Cuba

A nationwide campaign has reduced illiteracy from 23% in 1958 to 3.9%. Over two million people (out of seven million) attended schools and universities in 1963. Since 1958 primary school enrolment has almost doubled (1,280,000) and 5,000 extra classrooms have been built. Free and compulsory education will be increased from six to nine years.

Bulgaria

Since 1939 student enrolment has increased tenfold. Recent statistics rank Bulgaria in fourth place in the world for ratio of students to total popuplation.

Tunisia

Helped by an educational planning policy introduced in 1962 school attendance has risen sharply. Compared with ten years ago primary school enrolment has more than doubled and secondary school enrolment has tripled. The 1965-68 Plan for Economic and Social Development includes a literacy programme for 250,000 agricultural and industrial workers.

Mexico

Five hundred and forty-six new secondary schools will be built in Mexico following a decree recently signed by President Gustavo Doas Ordaz. Mexico is now building primary schools at the rate of 4,000 a year.

Saudi Arabia

Progress in providing education for girls is revealed by a tripled enrolment in the past three years. Four special schools for the blind have been opened, including one for girls. A new university has been set up in Jedda, a higher technical institute in Riydah and a petrology institute in Dhahran.

Venezuela

Venezuela's campaign for literacy has reduced the national illiteracy rate from 47% to 13% in six years. In the past five years primary school enrolment has nearly doubled and over 6,000 classrooms have been built. Over 26,000

Progress the world

workers have been trained under a programme sponsored by the Co-operative Education Institute which now plans to give vocational training to 60,000 young people.

Iran

Secondary school graduates of military age are drafted into an Educational Corps. After a short military course and an intensive teaching course, recruits are sent to isolated villages for 14 months to teach children and adults.

Uruguay

In Uruguay, whose illiteracy rate (9.69%) is one of the lowest in Latin America, education is free at all levels. Over 95% of children now attend school. Secondary school attendance has increased fourfold in the past two decades with a sharp rise in rural areas. Over 35% of university students and 53% of secondary school teachers are women.

Ghana

Science teachers for secondary schools and teacher training colleges are now being trained at the University College of Science Education, Cape Coast. A Department of Natural Resources is to be set up at the Faculty of Technology of Kwame Nkrumah University and will give science courses at a higher level.

Greece

Under a new law the following educational reforms are planned: education at all levels—from primary school to university—will be free; compulsory education will be extended to the age of 15; new universities will be set up at Janina and Patras and an Institute of Advanced Pedagogy will be opened in Athens.

Congo (Brazzaville)

A five-year education plan will provide schooling for virtually all children between the ages of six and fourteen. National goal for 1973 is to have nearly 5,000 classes and over 220,000 pupils.

Democratic Republic of Congo

In the past four years primary school attendance increased by half a million (to 2,000,000) and secondary school attendance has nearly quadrupled. The Congo has three universities and ten institutes of higher education.

Libya

To overcome the shortage of secondary teachers, the government has decided that all university graduates, except those in medicine and engineering, will teach in secondary schools for two years. This year the first engineers will graduate from the Institute of Technology set up with Unesco's aid.

Spain

The 1964-67 National Development Plan, includes the organization of literacy classes for 1,700,000 adults; 5,000 teachers have been trained in literacy class techniques. Education is now compulsory up to the age of 14; a programme to build 15,000 new schools has been launched.

Guinea

Under a seven-year economic development plan a campaign has been launched to reduce the country's 90% illiteracy rate. In the past six years primary schools have increased five-fold to 1,459, and school attendance four-fold to 170,000.

Malaysia

Malaysia devotes a quarter of its budget to education. The introduction of free and compulsory education in 1961 has raised attendance of school age children to 94%.

In every part of the world progress in education depends on the availability of more teachers on every level. Above, spacious hall of the teacher training college at Ondo, 200 miles north east of Lagos in Nigeria. Construction is not yet completed, but 450 students have already been attending lectures since May 1964. Below, setting up a library in the college. Unesco has sent a specialist adviser to Ondo, has contributed audio-visual material and granted fellowships.

Photos Unesco - Almasy

Which is it?

NEW WORLD OF TEACHING MACHINES OR BRAVE NEW TEACHING MACHINES ?

by Ted Morello

First grade primary school children learn to read with new teaching machine.

USIS

AT a time when the field of education is in worldwide ferment, a single instructional phenomenon has captured the attention not only of professionals but of laymen. It is the so-called "teaching machine revolution" or, more properly, "programmed instruction".

Some of the striking achievements attributed to programmed teaching under experimental conditions help to explain the fascination that auto-instruction exercises:

Children two and three years of age have been taught to read and type... Without teacher, textbook or homework eighth-grade pupils completed a full year's work in ninth-grade algebra in a single semester... Three University of Michigan students were taught by machine to speak fluent Spanish in half the time required by traditional methods... Studying for seven hours a day, an eleven-man group learned as much Russian in 10 days as they would have in one and a half semesters of conventional college study.

Referring particularly to emerging nations, one authority says: "We are convinced that programmed instruction can work miracles... in solving the world's educational problems."

A "programme" consists of instructional material designed to lead a pupil almost unaided and without error to a pre-selected level of learning by what amounts to a Pavlovian stimulus-response-reward pattern. Behind any programme lies the theory that the material must start with something familiar to the student and progress with increasing difficulty through steps so small that the student can move forward alone with reasonable assurance of responding correctly. A programme may be presented in book form or by mechanical devices (hence the designation, "teaching machine").

As a practical matter, programmed instruction has not yet progressed beyond the tentative, experimental stage. There are those who contend that it never will, for nothing approaching unanimity exists in academic reaction to this unknown quantity clamouring for acceptance.

Few innovations in teaching have generated so much debate. At one extreme are those whose missionary zeal for teaching machines borders on fanaticism. At the other are those who, for a variety of reasons, condemn them just as enthusiastically. In between is the overwhelming bulk of educators—uncertain, cautious, even suspicious, but hopeful, too, and eager to believe that here at last is a sign pointing down the royal road to learning.

By recent count there were in the United States alone well over 100 companies in the teaching machine field, and the number is growing. Considering this mechanical explosion, it is not surprising that educators don't even agree on what is and what is not a teaching machine. However, a definition by Dr. Douglas Porter, a programming authority at Harvard University, is fairly representative. Teaching machines, he says, are "devices which endeavour to alter

the course of learning by automatically presenting the student with a 'reward', or reinforcement, immediately after he has made a correct response... All these devices possess three operation characteristics: (a) they present a sequence of problem materials to the student; (b) they provide some means by which the student may record his solution to the problem; and (c) they automatically and immediately indicate correctness of the solution."

The fact that a student is responding frequently in an explicit manner gives him a constant check on what he is learning. Unlike a lecture situation, his active participation makes any lapse of attention immediately apparent to him. The impact of correction is infinitely greater because it comes immediately instead of days or weeks later, as in the case of written examinations. Finally, the immediate confirmation of correct response rewards and stimulates the pupil to further efforts.

One of the most striking features of auto-instruction is the fact that a student may move along at his own pace—neither held back by slow-learning classmates nor precipitated into an area for which he is unprepared.

Dr. B. F. Skinner, a Harvard psychologist who used laboratory pigeons to demonstrate the step-by-step learning that underlies teaching machine instruction, adds this important point:

"The machine itself, of course, does not teach. It simply brings the student into contact with the person who composed the material it presents. It is a labour-saving device because it can bring one programmer into contact with an indefinite number of students."

The Center for Programed Instruction, a nonprofit educational organization in New York City that acts as a worldwide clearing house for information in the field, puts it this way:

"A teaching machine has been likened to the binding of a book. Therefore, if a child learns anything, he will learn as a result of the material in the machine (i. e., the programme) rather than as a result of the teaching machine itself. The machine in actuality has very little to do with the process, and is in many cases unnecessary."

Indeed, research indicates that the mechanics of programme presentation—whether by book or machine—has little effect on results.

The mechanical aspect of programmed learning is a particularly sensitive one. Advocates of the system shy away from the term "teaching machine" in favour of "programmed learning", "automatic tutoring", "auto-instruction" or "psychomotor self-instruction". (The more implacable critics scoff at the system as "instant knowledge" or "canned genius.") Nevertheless, "teaching machine" persists among laymen as the most convenient and common designation.

CONT'D ON NEXT PAGE

Students given every chance to be right

A teaching machine may range from a device scarcely more sophisticated than the traditional student work book to a complex mechanical and even electronic tutor. that presents not only written but audio-visual material. There are about 100 models in various stages of development, of which about half are in limited or full production.

Regardless of simplicity or complexity, a teaching machine is only as effective as the programme—the instructional material—that it presents to the pupil. As Prof. Robert Glaser, who has devised programme books at the University of Pittsburgh, observes:

"The fact that it is a difficult and aversive task to programme material and a much easier task to build the accompanying hardware is indicated by the fact that at the present time machines outnumber programmes by a large factor. We are in the situation of having shells without innards."

That point was underscored when a school board spent $5,000 for 20 machines—and then discovered that no programmes were available for them.

MOST researchers are satisfied that there no longer is any doubt that programmed teaching is effective. ("Even a bad programme is a pretty good teacher", one experimenter says.) Emphasis now has shifted to making programmed teaching **efficient**—to preparing material that will guide a pupil in the desired direction without meaningless or even damaging departures.

A sound programme is one that has been prepared meticulously and tested rigorously. A programmer first tries it out on a single student, changing a word or phrase or adding or eliminating sections until the desired response emerges. One by one, as many as ten other students work through the material, which again is revised as necessary. Finally, the programme is group-tested. Ideally, it is then capable of teaching efficiently perhaps ninety-eight per cent of all students who are intellectually on a par with those who participated in the testing programme.

Wilbur Schramm, director of the Institute for Communications Research at Stanford University, says there has always been a "deadly inflexibility" about the age at which the average student was considered ready for any given instruction. Underscoring the necessity of meaningful programming, he then asks rhetorically:

"But suppose that readiness depends upon teaching method as well as upon subject matter. Suppose, for example, that a student is ready for the usual way of teaching geometry only in the tenth grade but is ready for another way of teaching it as early as the second grade? Suppose that, as in the Soviet Union, intelligence tests were to be minimized; and when a child could not understand an explanation or a concept, the blame were to be laid, not on the child's supposed lack of intelligence, but at least partly on the way the material is being taught? Suppose the testmakers were to think of their assignments not as selecting the fit from the unfit, but rather as selecting the kind of instructional methods which will fit different kinds of individuals?"

Programming falls into two broad categories: linear and branching. A linear programme tries to guide the student step by step toward a correct response, even prompting him with thinly veiled hints. Dr. Skinner, a principal proponent of linear programming, says:

"Teachers generally want students to be wrong. If everyone knows the answer to questions, teachers make them tougher. With teaching machines, you give the students every opportunity to be right."

In the branching approach the pupil who responds with the right answer moves along the trunk route to the next question. But if he responds incorrectly, he is detoured over explanatory material that provides the background to correct his error. As he absorbs the subsidiary material, he is led back, question by question, to the mainstream of instruction. In other words, the student is either presented with remedial material or accelerated to more advanced material.

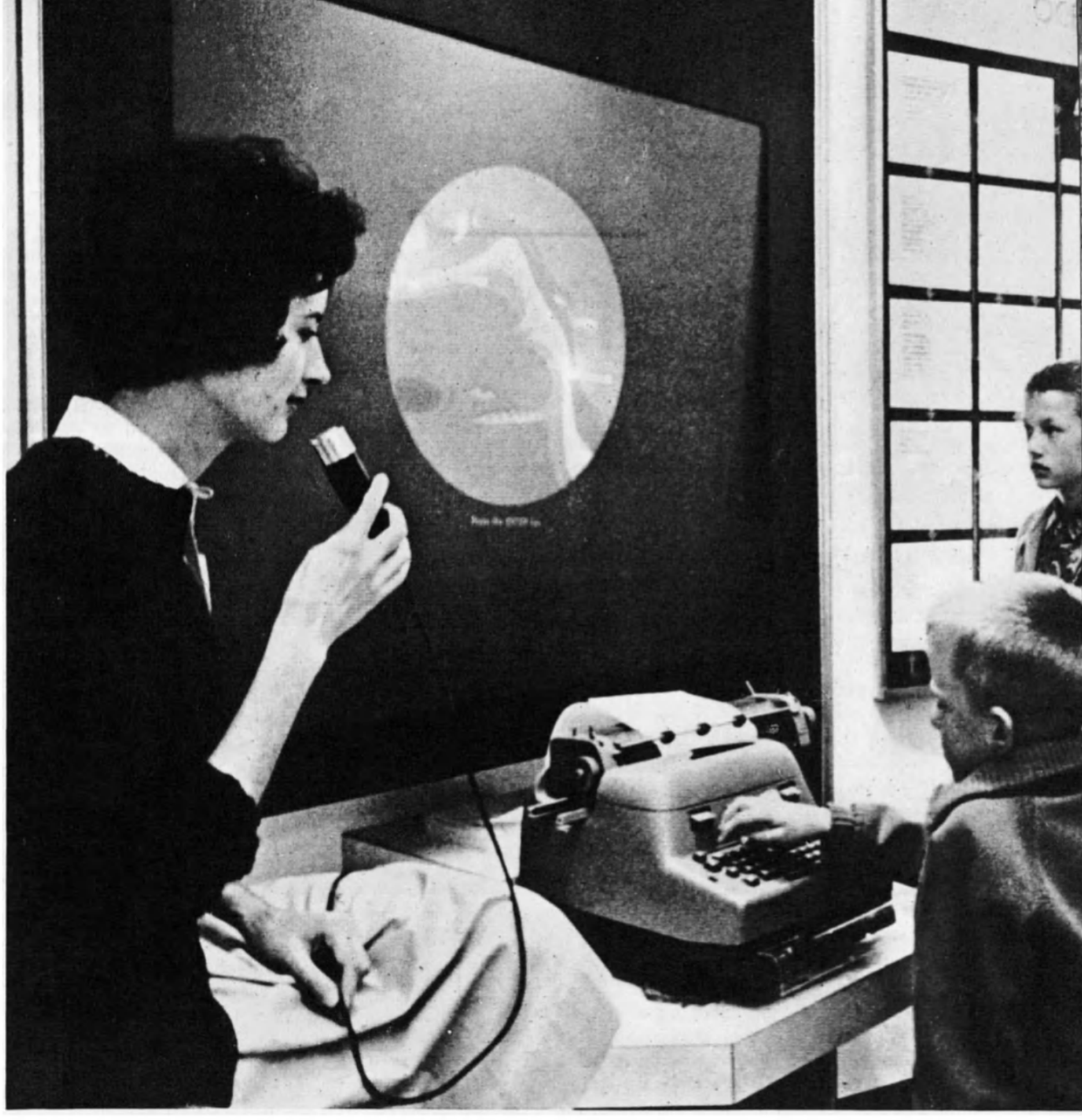
Programmed textbooks are by far the mostly widely used presentation method—indeed, virtually the **only** one in curricular use. This despite one major distinction between machine and text that favours the former. As one research team has pointed out: "With programmed texts, nothing but his conscience prevents the subject from gaining access to the correct answer prior to making his own response." Machines, on the other hand, are designed to be cheat-proof, mechanically serving up problems one by one and masking answers until the student has irrevocably responded.

Other devices for presenting the curriculum material include memory drums, rotating disks, film sequences, slides, index cards and magnetic tape recordings.

In terms of Dr. Porter's "operation characteristics", how a problem is presented depends on the design of the machine; but in general the problem ranges from short statement or question to a number of paragraphs presented either visually (film, television or in writing) or orally (by recordings) or both. The device then may either wait for the learner to respond before reacting (learner-paced) or it may move on to the next question at the end of a predetermined period of time (machine-paced).

THE second step—student response—may be taken in a variety of ways, again depending on machine design. The student may write a word or passage, punch a hole, push one or more buttons or indicate his reaction in some other way. Answer mechanisms tend to polarize toward "multiple-choice" on the one hand and "constructed response" on the other.

The final step—confirmation of the solution's correctness and reinforcement (reward)—likewise depends in form on the device used. Generally, revealing the answer by exposing more of the programme both grades a student's response and (when he is right) rewards him sufficiently. However, the reward may also sometimes take the form of flashing lights, bell-ringing, audio-visual evaluation, or—particularly for younger children—the vending of candy, marbles or small toys.



The boy at the typewriter is studying oceanography. The typewriter is part of a teaching machine used to demonstrate current research on the human learning process. A series of lessons and questions about oceanography appear on the screen before the student. He reads and responds by using the typewriter to answer the questions. The order of succeeding lessons depends on the appropriateness of his answers previously programmed in a digital computer.

USIS

Here is the step-by-step operation of one simple auto-instructional device programmed for basic arithmetic. The device consists of 12 sheets packaged in a cardboard folder. A window in the folder exposes a portion of one sheet: a box (or frame) containing one question or instructional paragraph or both, and a second box left blank for student response. When he has completed frame I, the pupil slides the sheet upward to frame 2, exposing the answer to frame 1, plus a new question or instructions and second box for the written answer to question 2.

Frame 1, for example, reads: "In arithmetic, we must **understand** numbers and what they mean if we are to get correct answers".

Because this is instructional material rather than a question, the "answer" box merely instructs: "Go to the next frame".

Frame 2 reads: "When we u.....d numbers in arithmetic we will get **correct** answers. Fill in the word". In the adjoining box the pupil is expected to write, "understand". He then moves the sheet upward, exposing frame 3, which contains the correct answer to the frame 2 question and presents the new instructional material: "We call the way numbers are put together a **system**". Frame 4 reads: "When we **understand** the number system, we will get (right/wrong) answers. Choose the right word. In the answer box the pupil writes, "right"—and, is rewarded when, on moving to frame 5, the word "right" is exposed as the correct response to the frame 4 question.

At its most revolutionary, programmed teaching not only guides a pupil through **what** to learn but shows him **how** to learn. The distinction is roughly equivalent to that between a lecturer and a tutor. Both provide facts, but the tutor additionally helps the student to learn them.

Since the system focuses on guiding a pupil to a correct response rather than trapping him into a wrong one, prompting is an integral part of programming. As specific examples of good and inadequate prompts, Dr. David J. Klaus, associate programme director for training and education at the American Institute for Research, in Pittsburgh, lists the following problems:

Example X: "Fahrenheit and centigrade are scales of temperature; Kelvin is a .....".

Example Y: "Fahrenheit and centigrade are scales of temperature; Kelvin is also a .....".

Dr. Klaus observes that example X is a poorly cued frame resembling "a test question rather than an aid to learning".

"By adding a single word, however, example Y illustrates a very good frame", he says. "It is almost impossible for a student to answer it incorrectly even if has never seen the word 'Kelvin' before."

What can be expected from auto-instructional devices?

CONT'D ON NEXT PAGE

Too costly for emerging countries ?

Three levels of programmed learning are usually mentioned. At the lowest is so-called rote learning of such material as vocabulary, arithmetic, spelling and the basic facts of history and geography. A step higher is conceptual learning in which a student not only must memorize facts but must be capable of handling a wider variety of problems and examples than can be specifically covered by the programme. Physics, statistics and economics present challenges in this direction. The most sophisticated instructional level involves the teaching of such capabilities as creative thinking and judgement.

"This may be the level of education at which auto-instruction will yield its greatest fruit", says Dr. Klaus. "The possibilities of developing a programme in this area are derived from two simple observations. First, we have sufficient data to indicate that creativity and judgement are examples of learned behaviour. Secondly, we have evidence to indicate that these behaviours can be taught. What is left is simply a problem of mechanics, that is, identifying exactly those behaviours to be learned and then finding the means to successfully establish these behaviours in the student's repertoire with auto-instructional methods and devices."

Yet it is precisely at this point that many educators split with teaching machine enthusiasts. For while conceding the device's role in purely quantitative teaching, they are dubious about a machine's effectiveness as an instructor in qualitative subjects.

In terms of the number of programmes available, the field is dominated by mathematics, which lends itself to programmed instruction because it is a subject of precise answers that can be learned in small steps. English, including reading and spelling, is probably second, followed by psychology, foreign languages and physics.

Dr. Edward B. Fry, a teaching machine researcher at the University of Southern California, remarks:

"It is probably quite safe to say that in the next few years some programme will have been developed for every subject taught in our schools."

A contrary view comes from Dr. George D. Stoddard, chancellor of New York University. He accords the machine a place as an instructor in facts, formulas, vocabulary and grammatical rules. But he fears that such instructional methods will stultify rather than stimulate a child's thinking, creative and performing processes.

"Perhaps a live teacher who infuriates a student is better than a machine that leaves him stuffed with information but cold as a mackerel," Dr. Stoddard says.

Much of the hostility toward auto-instruction is based on economics; despite assurances to the contrary, many teachers fear that machines will replace them. One so far betrayed his hostility as to fail thirty per cent of a class that had come to him via a programme-taught preliminary course. And in at least two cases, indignant school administrators have demanded legislation barring programmed instruction from classrooms.

Among parents and laymen generally, opposition is often based on sentiment—the fear that "traditional" relationships between pupil and teacher will be destroyed.

Both categories of opponents visualize varying degrees of automation, ranging up to the extreme of a 100 per cent mechanized educational system from kindergarten through university.

Proponents of the system scoff at such fears as groundless. They reply that, with or without machines, programmes can liberate teachers from the drudgery of purely mechanical instruction so that they may be free for "those inspirational and thought-stimulating activities which are, presumably, the real function of the teacher," in the words of Dr. S.L. Pressey, the Ohio State University psychologist generally regarded as the precursor of the teaching machine revolution.

ONE educator has said in the machine's defence: "A human being should not be wasted in doing what 40 sheets of paper or two phonographs can do. Just because personal teaching is precious and can do what books and apparatus can not, it should be saved for its peculiar work. The best teacher uses books and appliances as well as his own insight, sympathy and magnetism."

Auto-instruction would be irresistible even if its only promised advantage were an impressive speedup in educating the world's children. (Dr. A.A. Lumsdaine, an education psychologist at the University of California, Los Angeles, predicts that with machines, "bright pupils will be able to finish the grade school curriculum by the time they are 10 years old instead of 14"). The fact is, programmed instruction is enormously attractive for other reasons.

In a world clamouring for more and more teachers, programmed learning seems to offer a way of spreading out the available supply. And with the soaring cost of elaborate school buildings beyond the reach of impoverished and even of many advanced nations, machines which can be used in buildings of monastic simplicity or even at home seem to be a budgetary blessing. Attracted by these and other considerations, educators from Latin America, Asia, Africa and Europe are eagerly watching developments in the field. The first experimental steps already are being taken in Sweden, France, Great Britain, Japan, West Germany, South Africa and Nigeria.

Prof. Arthur French of Makerere College in Kampala, Uganda, admits that there is widespread interest among African educators ; but he adds that many administrators are intimidated by the cost of teaching machines. Programmers not affiliated with commercial "teaching machine" manufacturers tend to agree that emerging countries would be unwise to invest heavily in mechanical devices now. Says P. Kenneth Komoski, president of the Center for Programed Instruction:

"We are not going to help a country that is trying desperately to create or acquire traditional textbooks by telling them we have better books that cost more (as indeed they do!). In fact, the less emphasis we put on the products of programmed instruction, i.e., programmed texts and teaching machines, the better off we will be. For one thing, teaching machines will not work in developing countries today for the simple reason that they do not work in this country. They simply have not been sufficiently debugged... I believe we would be foolhardy to chance mechanical failure so far from home."

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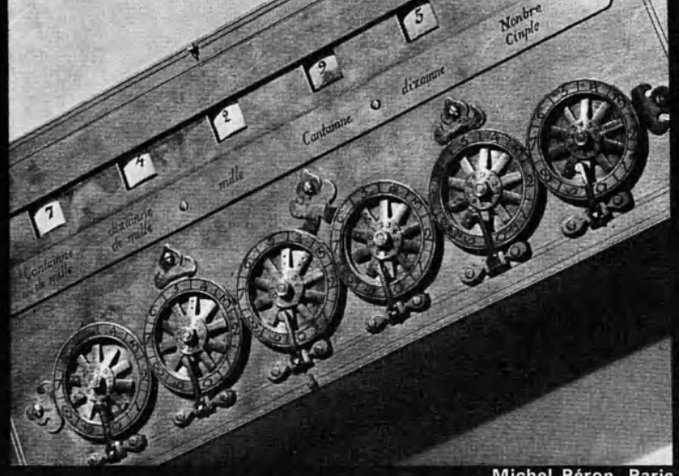
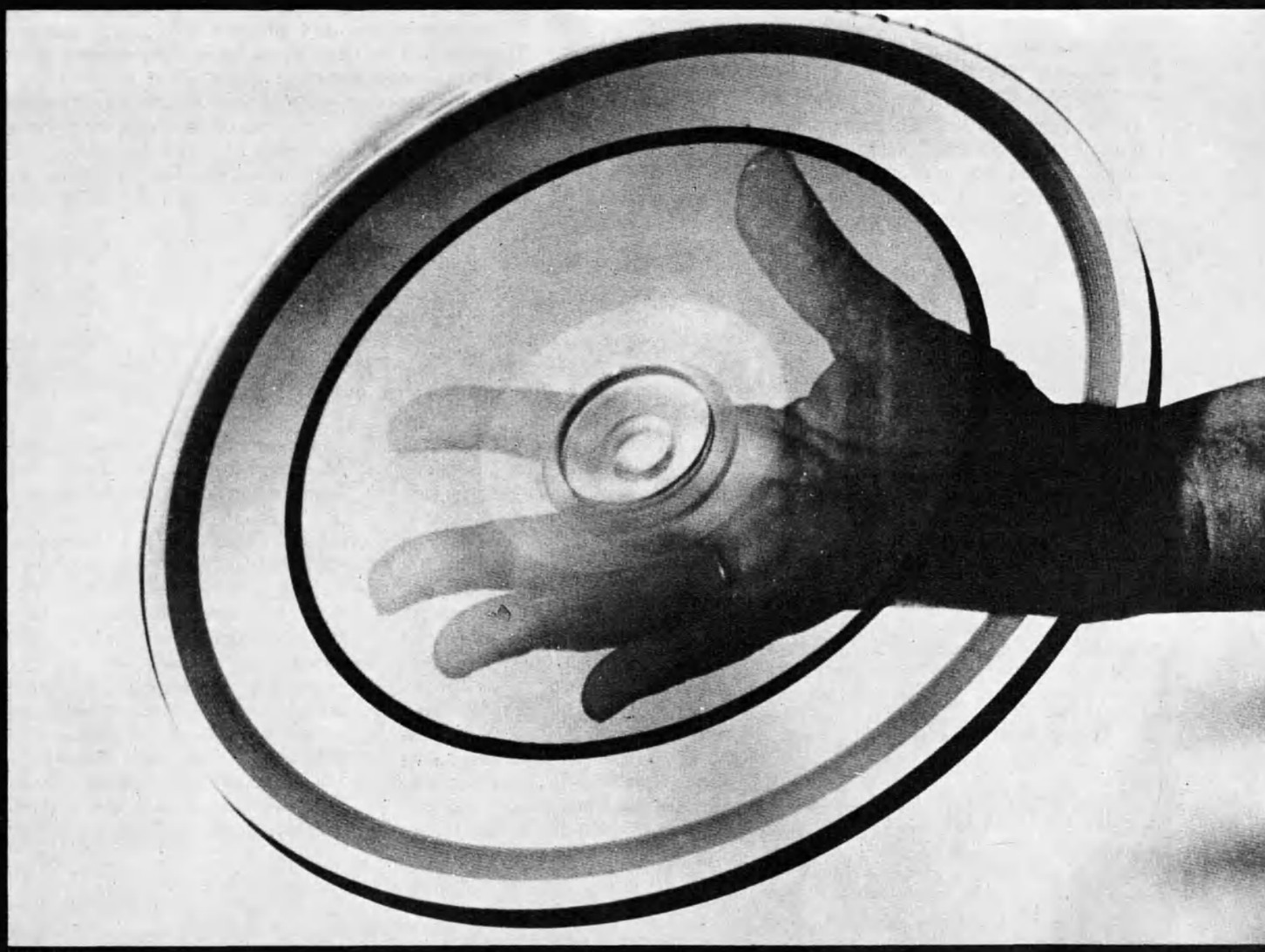
Palais de la Découverte, Paris



Michel Péron, Paris

CALCULATED DISK

Advanced research in programmed instruction is making increasing use of the potentialities of the electronic computer. In the United States computers have been used experimentally in group and individual learning exercises and examinations. Below, computer memory disk capable of recording 500,000 words in the shaded area. Above and left, the great ancestor of our modern computers, Pascal's mechanical calculator, now preserved in a Paris museum (detail shown on cover). It is operated by turning the series of wheels; results then appear in the sight holes at top of cover.



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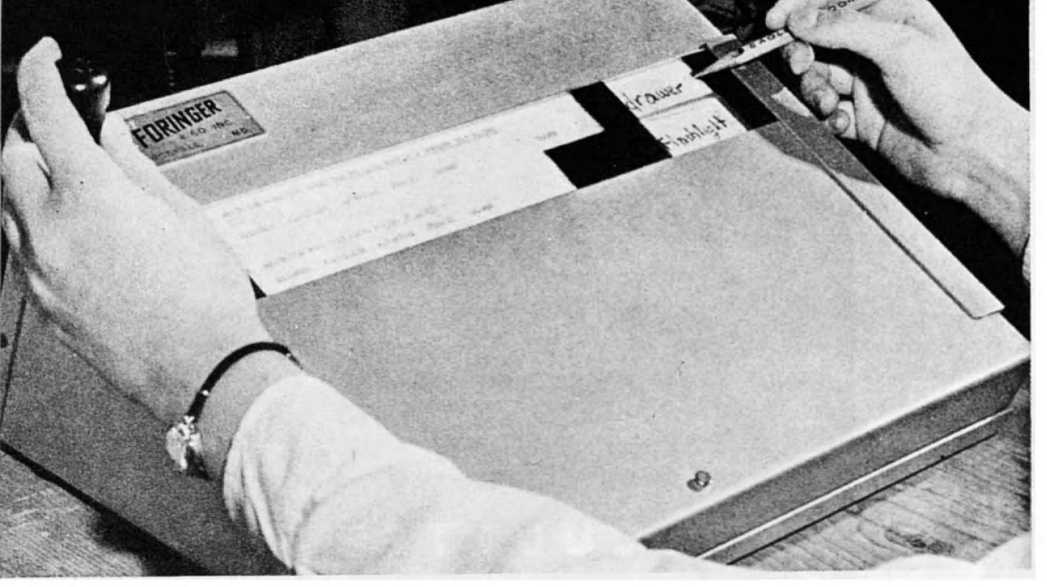

A simple teaching machine operated with a typewriter roller action. Student writes answer to question in window on right and can go on to the next question if he is correct.

From "The World of Teaching Machines" © 1961, Electronic Teaching Laboratories, Washington, D.C.

TEACHING MACHINES *(Cont'd)*

A new technique of unlimited potential

For the immediate future, Mr. Komoski suggests, emphasis should fall on "finding out how the principles of programmed instruction may be generalized to all instructional situations and applied to all available media" regardless of culture. Such an approach is aimed at solving two great unknowns about the prospect of worldwide use of programmed instruction: (a) To what extent can programmed instruction, still an almost wholly American phenomenon, be transferred merely by programme translation to another nation—even an English-speaking one? (b) How many of the principles applicable to American-oriented programme instruction would be valid in constructing indigenous programmes in other languages for peoples of other nationalities, cultures or educational levels?

While admitting that almost nothing is known about programmed instruction except that it works, educational psychologists in the field nevertheless are confident that it is a new weapon of unlimited potential in the worldwide war against ignorance. Pointing out that the global need for teaching of literacy and technology "is so vast as to be almost beyond comprehension," Dr. Schramm says:

"Could an intelligent use of programmed instruction significantly reduce the time and money required for that task? Everyone who is familiar with programmed instruction and has looked closely at the needs of the new states is most optimistic about what could be accomplished. These countries are desperately short of teachers; here is a device to multiply good teachers. These countries have unusual motivations to learn; here is a device to take advantage of these motivations and provide a tool for self-teaching. These countries have need for a considerable amount of expert and specialized teaching which is often not within the competence of many of their teachers. Countless one-room schools are in charge of teachers who themselves have only four to six years of education. How much the learning opportunity of those one-room schools could be increased by the addition of a small library of well-made programmes."

Unesco 'workshops' on programmed instruction

FOR several years Unesco has been studying the possibilities of introducing programmed instruction in developing nations. In 1963 it held "workshops" on programmed instruction in Ramallah (Jordan) and Ibadan (Nigeria) to introduce to educators in the Middle East and West Africa the techniques of programming instructional materials. In 1964 another workshop was held at Accra (Ghana) and a work conference took place in Zaria (Nigeria). Programmed instruction materials were also developed in 1963-64 in Sao Paulo, Brazil, where a Unesco pilot project on physics teaching was launched. In 1965 two workshops are planned for French-speaking African countries (in Madagascar) and for Arab educators concerned with teacher training. For further information on programmed instruction and other new techniques in education see "Programmed Instruction in West Africa and the Arab States" and "New Methods and Techniques in Education" (Nos. 52 and 48 in the Unesco publications series "Educational Studies and Documents"; $1.00; 5/-; 3,50 F.).

SCIENCE AND THE COMMON MAN

by Ritchie Calder **(Part two)**

This is a "portrait" of the mathematical concept of geometric progression. In the series of reflections each boy is half as high as the next larger boy. The sequence of heights forms a geometric progression. There are infinitely many boys in the picture but if they stood on each others heads, the resulting tower would not be infinitely high. It would only be twice as high as the boy seen in the first mirror.

IBM

In past times a "man of science" could converse and communicate with any other educated man. Today the cryptic language and private jargons of the scientist have built barriers between the ordinary man and a proper understanding of science —the social dynamic of our times. In our February issue, Ritchie Calder reviewed these obstacles and stressed the dangers for our civilization and for science itself of the gulf separating the scientist in his specialty from the wider community. Here we present the second part of his article.

MAN'S anxiety about his own search for knowledge and for power is reflected almost universally in myth and legend and still lurks in our own nature today. Prometheus, in stealing fire, the prerogative of the gods and appropriating it for the use of man, was terribly punished for his presumptuous act. Pandora wantonly unleashed forces which she could not control because, again, she trespassed on the jurisdiction of the gods, but since her action was accidental and innocent, mankind was at least left with hope.

But when Faust invoked the Devil in order to usurp the powers of the gods, there was nothing accidental about his actions and he was consequently doomed to everlasting punishment. The association of acquisitive knowledge with evil and punishment is to be found in the story of the Garden of Eden, and also in the ancient Egyptian saying: "When man learns what it is that moves the stars, the

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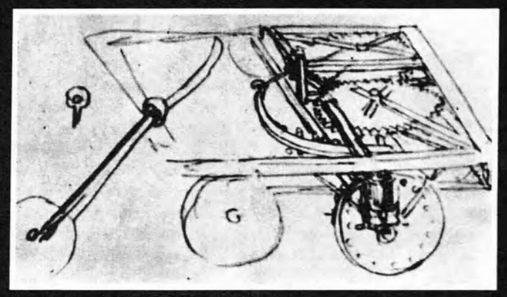
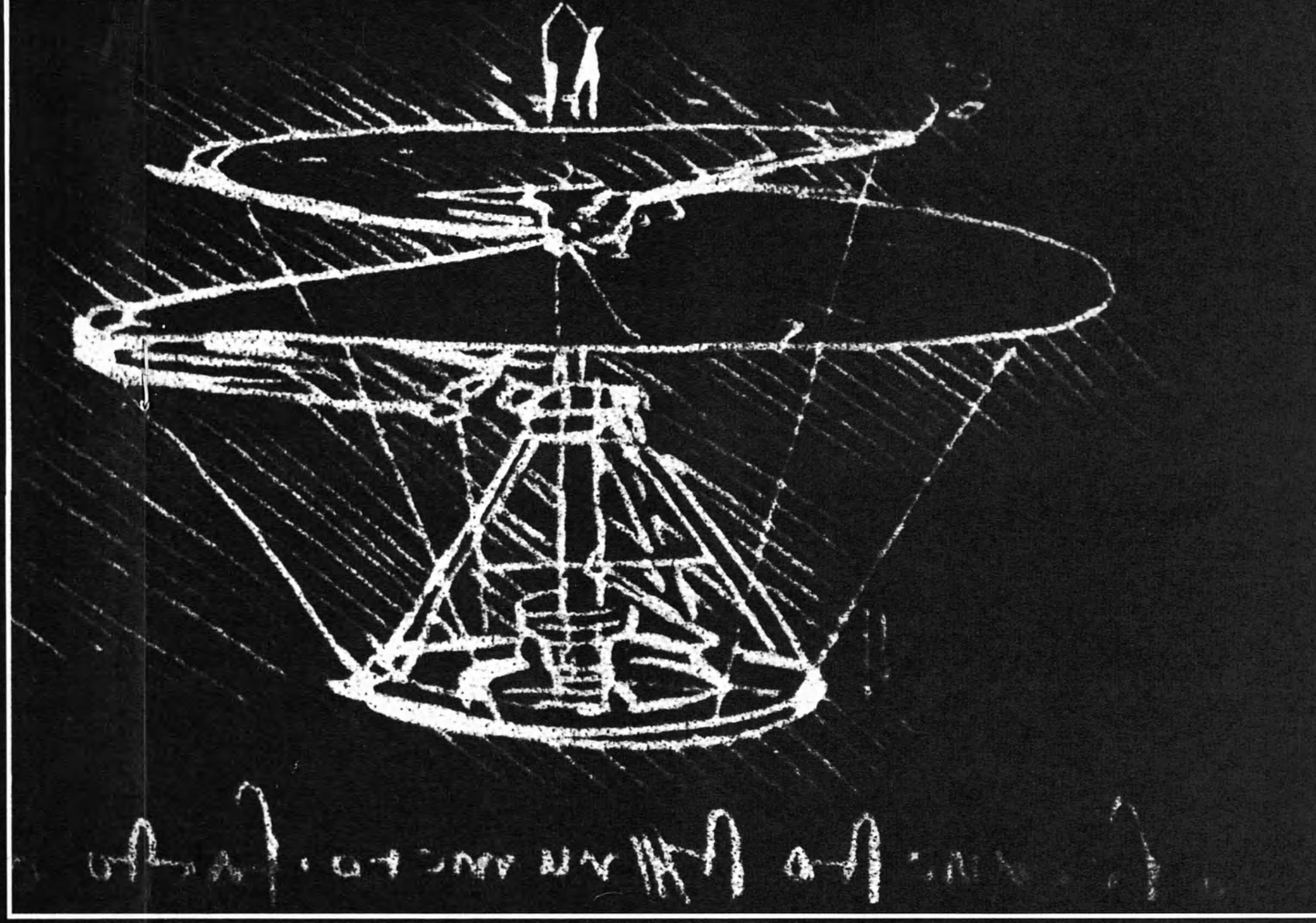
Models of Leonardo da Vinci's automobile, helicopter, aeroplane



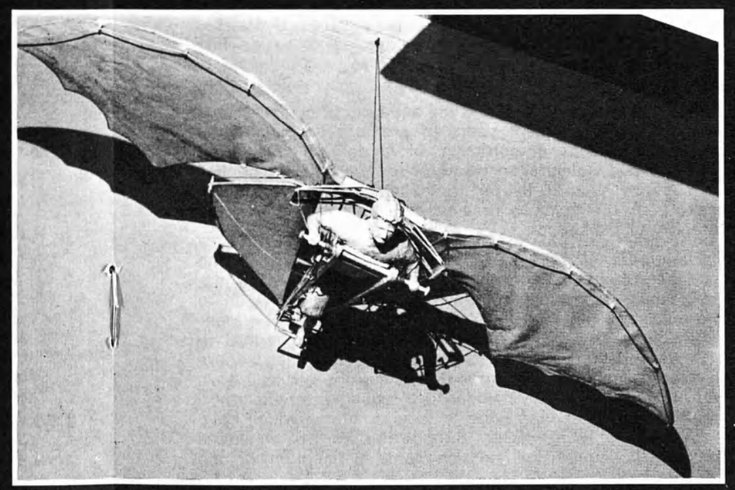
Four centuries before their invention, the automobile, the helicopter, the aeroplane, the parachute and many other modern machines had already been foreseen by one of the keenest minds of the Italian Renaissance. Giant among painters, musician and poet, Leonardo da Vinci in fact considered himself first and foremost a man of science and an engineer. Here we present some examples of his inventions in the form of present-day models built to Leonardo's drawings and notes. Below, a model of the earliest-known design for a self-propelled vehicle. Based on Leonardo's drawing (left), it is spring driven.

Photo © Three Lions, New York



Photos Michel Péron, Paris

HELICOPTER. This drawing by Leonardo da Vinci, illustrating the principle of the "airscrew", is a preview of the helicopter. But the only motive power Leonardo could give it was the strength of the human arm (model right). The inventor took the precaution to write his scientific notes so that they could only be deciphered when reflected in a mirror.



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AEROPLANE. Leonardo studied the flight of birds and also experimented to discover how much lift could be obtained from wings. This model of an aeroplane embodies the ideas in his drawings and notes.

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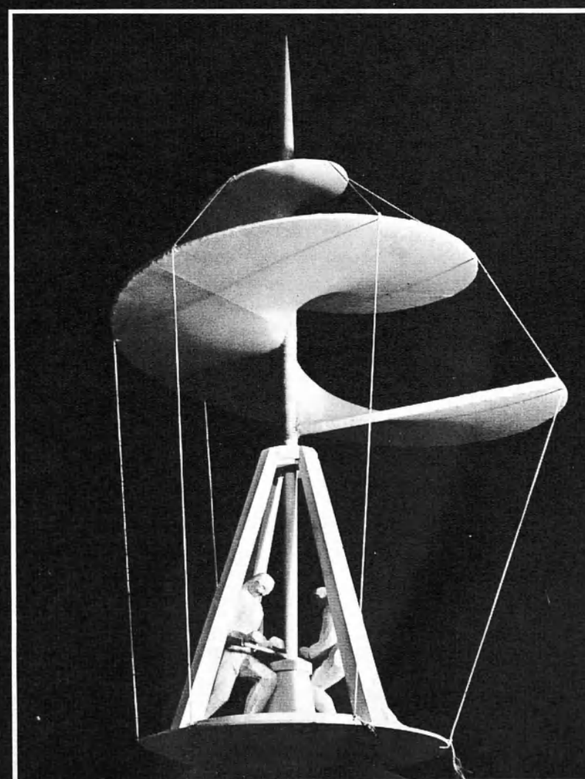
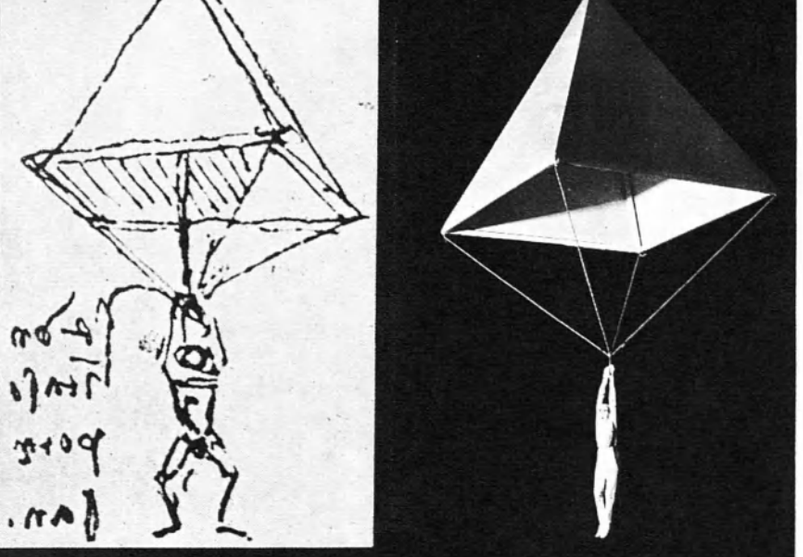
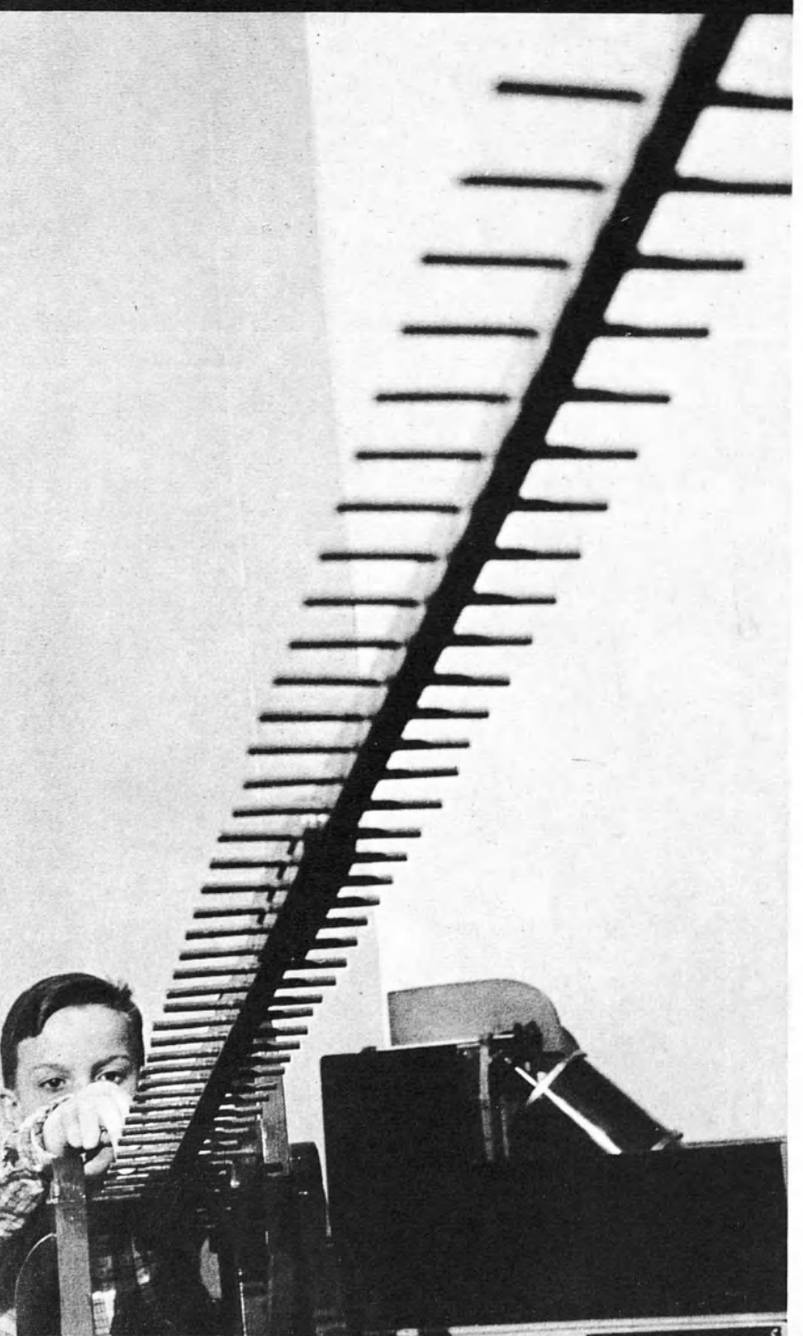




DA VINCI *(Cont'd)* Photos Michel Péron

FROM PARACHUTE TO FIREMAN'S LADDER. The versatile genius of Leonardo da Vinci found expression in the most diverse fields of art, science and technology. Documents bequeathed to us by Leonardo abound in creative ideas for inventions such as hydraulic machines, excavators, piledrivers, cranes, swinging bridges, spinning and weaving machines, diving equipment and many others. Above, da Vinci's own drawing and a model of the parachute he designed. Below, this mechanical model of a scaling ladder built to Leonardo's blueprint has a similarity in some respects to ladders used on fire engines today.

© Three Lions, New York



The fear of being afraid

Sphinx will laugh and all life upon earth will be destroyed."

There is a built-in fear in most people that trespassing in the Unknown will invite a kind of cosmic revenge on mankind or, as the psychologists put it, "the tendency to relapse into more primitive forms of thought and feeling which is characteristic of much of the psychological reactions of the public to nuclear energy can be ascribed to a psychological mechanism known as 'regression' ".

There is no safety in ignorance. In October 1957, the World Health Organization called together a group, of which I was a member, to study the mental health aspects of the peaceful uses of energy. One of the questions studied by this group was apathy. One would have assumed that this was a sort of emotional carapace, but it was not: it was the "fear of being afraid". People knew enough, sensed enough, or guessed enough to have their unspoken fears, and they shrank from facts which might confirm or exaggerate those fears. Their attitude was not "don't care" but "don't want to know". And the psychologists recognized of course that this abdication does not produce reassurance but a neurosis which in the mass can give rise to social malaise. It is better to have rational fears than irrational ones.

AND so nuclear superstition grew up. The only way to combat superstition is to confront it with reason. But what happens if the custodians of reason are not believed? The study group found that scientists themselves were mistrusted. In part this was due to the primitive sense that they were interfering with things which they should not touch, but also in part to the manifest evidence of their achievements—people remember the bomb but they forget penicillin. But the most serious part was the distrust of the motivations of the scientists' evidence.

If the release of atomic energy had not happened behind the silent walls of secrecy, if there had been free discussion among scientists everywhere, the processes of the discovery and the release would have "got through to the public" and would have prepared people for the greatest achievement of man since he mastered fire. Instead, without any preparation of the public, it exploded with the violence of a bomb. The conditions of military secrecy continued and, also, the fears engendered by the original bombs persisted because of the testing of bigger and bigger weapons.

Scientists became the spokesmen of government policies. They were called upon not only to give the facts, within the limitation of their specialized knowledge but to extrapolate those facts beyond that knowledge and to pass judgements and to express opinions.

The fact that scientists, and the authority of science, have been invoked in recent years to promote policies, or to win appropriations or contracts, or to defend government agencies and industrial concerns, or to "reassure the public" on subjects such as fall-out or thalidomide, has tended to make people suspicious of their motives and question the integrity of their facts.

Even more difficult to analyse than the relationship of the scientist to the general public is the relationship of the politician to the scientist; it is a love-hate relationship. As the published report of the WHO Study Group on the Mental Aspects of Atomic Energy (1) stated: "With regard to science and the scientists, the position of political leaders is often fraught with additional difficulties. Few, if any, have the background which includes a thorough scientific training, yet they are called upon to face situations which have been built up, little by little, through the work of scientists and which require for solution some conception of the ultimate implications of the scientific world...

"Lack of adequate conceptual background may lead to

...and the philosophy of risk

a tendency to make a programme without real plans, and this can lead to tremendous insecurity."

"Another aspect which generates anxiety is the uncertainty about who actually wields the power," said the WHO report. "In one sense, the politician has power over the scientist, but in another, he is dependent on the scientist and hence is in his power. In this respect an entirely new situation has arisen in many countries of the modern world."

This danger of "the tyranny of the expert" is, and should be, a matter of real public concern. The faceless men at the elbows of the scientifically uneducated are becoming decision-makers without being answerable to the community.

Scientists do not make the task of common understanding any easier when they vacillate between statements which are limited to their scientific competence and statements which wear a meretricious mantle of science but which are actually expressions of value and even of policy decision.

One of the value judgements passing as scientific truths is the concept of "maximum permissible dosage" of radiation. This belongs not to science but to the "philosophy of risk." It has no more scientific authority than the forty-mile-an-hour speed-limit sign on a highway, yet scientists, including many eminent ones, have got into the habit of quoting "m.p.d.s" as though they were scientific units. The bandying of "m.p.d.s" by spokesmen-scientists in discussing such things as fall-out, either to minimize or exaggerate the risks, has bamboozled the public and increased its distrust of the scientist.

In November 1963, the World Health Organization, the Food and Agriculture Organization and the International Atomic Energy Agency, brought together world experts at Geneva to consider the radiation hazards from peacetime accidents. This meeting followed the suspension of tests, so that the official scientists were no longer looking over their shoulders, speaking with their tongues in their cheeks, nor waiting for government reprimands if they said anything which, even if true, would be officially indiscreet.

The consensus of that meeting was that in terms of the population at large **no** dosage was **permissible**, neither maximal nor minimal. All radiation beyond the natural was to be assumed to be bad. If an accident to a nuclear installation was to occur and there was to be an escape of radiation of any kind, no one was to say: "Until the dosage is so-and-so, there is nothing to worry about." Everyone's job, urgently, must be to restore the environment to normal. A pseudo-scientific unit which had bewildered the public for eighteen years was thus discarded, as far as public health was concerned, although its usefulness as a guide to risk still applied to the radiological protection of individuals.

OVER a century ago, the famous French physiologist, Claude Bernard, made a pronouncement which his modern successors would do well to heed: "True science teaches us to doubt and, in ignorance, to refrain." When the entire living environment has become a laboratory, scientists ought to be restrained within the limits of their knowledge; they ought to admit to themselves what they do not know. Fall-out is a case in point (although we can think also of pesticides and new drugs like thalidomide) because it should remind them to compare notes with their colleagues in other disciplines.

Another saying of Claude Bernard applies to the responsibilities of the modern scientists: "When you enter your laboratory, put off your imagination as you take off your coat; but put it on again, with your overcoat, when you leave. Before an experiment and between whiles let your imagination wrap you round; put it right away from you during the experiment itself lest it hamper you and your power of observation."

Outside his laboratory, the scientist is entitled to use his imagination in politics, in religion, or in any other social concern. Indeed, it is his duty to do so. He ought to have some regard for the use, misuse, abuse, or non-use of his discoveries. He is a functional citizen and should be expected, as the repository of information, to make that information intelligibly available, and, also, with a sense of responsibility, to put forward arguments on which social judgements can be sensibly made and without which social judgements cannot be made.

Today, many scientists, including the most eminent, earnestly accept this responsibility. They take the initiative on great issues—issues which science itself dictates—without arrogating to themselves the powers of the invisible experts, the faceless men, and bring their knowledge to the bar of public opinion. The Pugwash Movement is the conspicuous and impressive example of this. Scientists, in this way, can form a very powerful benevolent "lobby" in the interest of the lives and livelihoods of their fellow humans.

COMMON understanding of science does not mean just what is conveyed through the popular press or radio or television or films, much of which is now being done very ably and is introducing the ordinary person not only to the exciting developments of science but to the ways in which the scientist goes to work. Science has to be understood at all levels. If we are to have science effectively administered by governments and public bodies or by the boards of industries, we have to educate those who are to form the judgements about sciences and to decide priorities. Men of affairs have to be sufficiently well informed to know what it is that the scientist is talking about, otherwise they may find themselves carried away by the enthusiasm of the scientist, caught by the glamour of the latest "scientific cult" or just bemused by the jargon of science. Conversely, much that is worthwhile goes a-begging because those who have to take the decisions cannot properly understand.

This problem is one of education, at all ages. When people ask "At what age do you teach a child science?" the answer is simple: from the moment a child lisps "Why?" Innate curiosity has to be encouraged instead of the child being told: "Wait until you know all about kinetics and dynamics and you will understand." To discourage curiosity is to discourage scientific inquiry in later years.

Recently, at an educational conference, I was asked to speak on "Teaching science in general education in the year A.D. 2000". I said I hoped that we would not be teaching "science" as a subject in general education forty years from now, but that science would pervade—be as natural as the blood corpuscles—and that specialization would be reserved for much later in the student's life. Moreover, every university student should be introduced to scientific method and given the background which will make him, even when he is not going to be a career scientist, capable of evaluating science.

An essential attribute of the rounded man in this day and age is that he should know about the forces which are changing and dominating his life and affecting culture in all its aspects. This is a challenge to educators in every country—those which we call "developing" as well as those which are highly developed scientifically and technologically.

In all this, the present-day science writers have a peculiar

(1) No. 151 of the Technical Reports series, Geneva, WHO, 1958.

CONT'D ON NEXT PAGE

The inalienable right of curiosity

responsibility. There are not enough of them and not all of them understand, nor do all of whose who do understand accept the function of social interpretation which has been elaborated here. Many regard their "popularization" merely as the explanation of the latest gadget or of the latest cure or of some exciting new theory. This is the easiest of all science writing.

If the scientist, who has the facts, is patient, and the journalist, who has to simplify these facts, is patient, there is practically no scientific advance however abstruse it may seem at first sight which cannot be made intelligible to the general reader. The expositor may be a science graduate trained as a journalist or a journalist who has acquired the necessary background of science. In either case, he (or she) must have the craft of presenting difficult concepts in ways which will arrest and hold the interest of readers (or listeners or viewers) who are not predisposed to science.

There are many layers of explanation. The scientist writing in his own scientific journal, for his own immediate colleagues, can use all the jargon he likes. If he is writing for a wider scientific group, he has to be less cryptic and more descriptive but he can still assume (a) that they know the basic concepts and (b) that they will concentrate on what he is trying to explain.

Then there are journals **about** science (as distinct from scientific journals) purveying a great variety of scientific subjects for earnest people who may not be scientists but who want to keep themselves informed. Such journals perform a very important function because they "brief" well-meaning politicians, civil servants, company directors, teachers of the humanities, etc.; they are for an educated élite who will grapple with a subject provided that the language does not defeat them.

Then there are the "serious" newspapers which will give space for explanations and whose readers will give attention, again provided that they are not expected to understand the terminology until they have been introduced to it. Then there are the large-circulation newspapers the function of which is to inform (or entertain) rather than to educate. This means "sneaking up on the reader" and surprising him into being interested in a subject which he would otherwise avoid.

AND there is the level of the "comic strip" which is not to be altogether despised. In Britain a whole generation was prepared for space travel, years before the first space capsule was launched into orbit, by the "Adventures of Dan Dare". Children knew far more than the grown-ups about Mach numbers, weightlessness, orbits and stagings. This was impressed upon me by a fourteen-year-old who, on the morning Sputnik I went up, asked how it was done. I told him all about propellants, boosters, etc. He listened to me politely and then said: "I know all that. But how did they get it into that particular orbit?" He was more interested in the science than in the technology. His instructor had been Dan Dare, a comic strip with a great amount of substantial information built-in. For "journals" and "newspapers" read films, television and radio. The same considerations apply.

The mere explanation of science, however, is not enough; it has to be translated into the lives and experience of ordinary people. There have to be, in this day and age, interpreters.

The crisis of our times is the breakdown of communications, not only in the semantics of politics and ideologies, but in this all-important area of science. Our lives, our hopes, our survival as a species depend upon the uses which are made of science. To progress, we have to use scientific discoveries and knowledge to the utmost. Science in the advanced countries is moving so fast that it is almost impossible to keep up with the knowledge and the gadgets.

Science feeds fundamental truths to technology; technology feeds back more and more elaborate instruments to science; they speed each other up. Over three and a half million original scientific papers are published every year and the increase is exponential. Wisdom is being drowned in a Niagara of information. The various branches of science are out of step, encouraged or discouraged by "cults" which impress the money-givers into providing disproportionate budgets.

Large areas of science are still enclosed within the barbed wire of military security. Much is circumscribed by industrial secrecy. Much more is fenced off by the jargon of over-specialization. One set of scientists does not know what another set is doing, even when their areas of work impinge and may have a critical relevance to each other.

IN the aggregation of experimental knowledge we have lost the sense of natural philosophy. With a singlemindedness that would have astounded the eighteenth century, schools of research pursue their objectives. We are now in the cult of DNA and the study of deoxyribonucleic acid and molecular biology—probing the secret of life before we know what we are going to do with it when we have got it. Over $6,000 million a year is spent on space research—only a small fraction of the $43,000 million which the nations spend on armaments, but twice as much as is invested in the developing countries.

There are too few communicators within science and between the humanities and science. How are we to teach people about science to enable them to make judgements and to see that, with the inalienable rights of curiosity and the quest for knowledge unimpaired, science, with all its potential for good or evil, shall be directed to the benefit of all mankind?

While we should certainly be encouraging the aspirations of Man in breaking the gravitational boundary walls of his planet, are we really maintaining at the same time a proper sense of priorities? How much more resources and attention should we be giving to the problems of this planet on which 3,000 million people today and 4,000 millions by 1980 will have to contrive to live in conditions more consistent with human dignity than most of them now enjoy?

Is space adventure more important than food and population problems for instance? And how, with all the spectacular advances of today, can we close the widening gap between the prosperity, scientifically and technologically produced, in the advanced countries and the poverty of two-thirds of the world?

The United Nations Conference on the Application of Science and Technology for the Benefit of Less Developed Areas, at Geneva, in February 1963, spelled out what we know and what is needed. While we would be grateful for some new breakthrough—giving to food problems, for example, the kind of answers which sulpha drugs, antibiotics and DDT gave to medical services—it was evident from that conference that there are answers already waiting to be applied, and that it is not a question of knowledge but of intention. It is a question of sharing knowledge and skills and resources that we already have at our disposal.

These are social judgements, fraught with stupendous meaning, and they must be based on a proper understanding of science and what it can make available. This transfer of knowledge and skills has to be done rapidly if the Scientific and Technological Revolution is to give substance to the Revolution of Rising Expectations, which, as more and more countries become independent, becomes more and more insistent.

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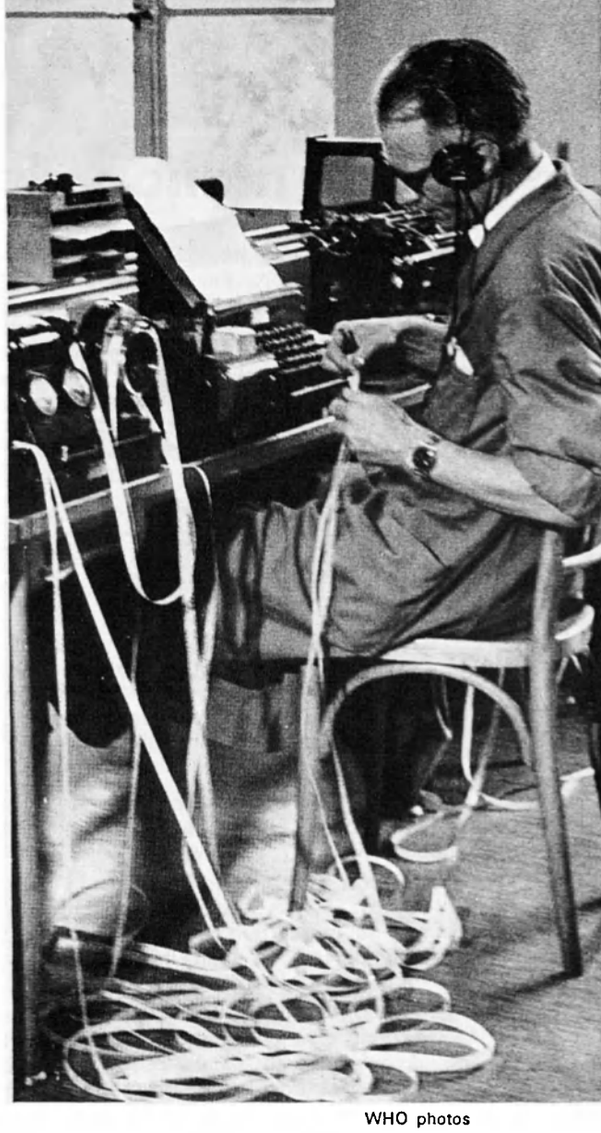
Underwater village

Part of "village" built 40 feet below the surface of the Red Sea by French undersea expedition of Commandant Jacques-Yves Cousteau. This feat was recorded in the film, "World Without Sun" from which photo is taken. Building with onion dome is a garage for the diving saucer in foreground. Occupying specially designed houses, oceanauts learned to adapt to life on the sea bed. As Commandant Cousteau has written: "Our team is bent on solving the problem of living under water at depths of up to 600 feet. If we succeed we shall have given mankind the ability to colonize the shallow seas fringing most large land masses." Progress in science and technology is leading to exploitation of new environments, as explained in article on page 4.

MUMMY OF RAMESES V

The mummified face of the Egyptian Pharaoh, Rameses V, shows clear traces of a some terrible disease. Medical historians say it was smallpox.

International co-operation in health began in the last century under pressure from deadly diseases that were causing suffering and death all over the world. In 1965, International Co-operation Year, World Health Day is being devoted to one of these diseases—smallpox. World Health Day 1965 will serve to focus attention on the campaign to eradicate smallpox from the world which was launched by the World Health Organization in 1958. As Dr. M. G. Candau, Director-General of WHO has declared : "The complete eradication of smallpox would not only rid the world of a disease which at present is a constant menace but would also provide an example of what true international co-operation can achieve." In the meantime the world will need to maintain a constant alert against smallpox.



In the days of swift air travel smallpox can be transmitted from continent to continent within hours. Information on all reported cases goes to WHO in Geneva which immediately operates a world-wide warning system. These emergency warning messages are given a priority over international cables.

WHO photos

Geneva : world headquarters in the fight against smallpox

NMAPQ KWABJ BADBO. This text of an urgent telegram addressed to "Epidnations, Geneve", and written in "Codepid", a world code for messages about quarantinable diseases, tells the WHO International Quarantine Service that a case of smallpox has been diagnosed in Aden on January 15. One man sick in a hospital is news for the world when the disease is smallpox.

From Geneva, cables are sent to neighbouring countries as well as to countries connected with Aden by airline services. The information also goes by short-wave radio to all continents. It is picked up by national health administrations, by port health officers, by ships at sea, by airplanes in the sky. By radio teleprinter service it goes to European countries and to North America. It is repeated in the Weekly Epidemiological Record printed in Geneva and distributed by airmail.

For the next days and weeks, special precautions will be taken by health authorities all over the world passengers arriving from or having passed through Aden.

Incoming telegrams in Geneva about quarantinable diseases number about 3,000 a year. From them an overall picture of the world smallpox situation can be built up.

In 1963, over 100,000 cases of smallpox were recorded. India reported over 60,000 cases; Indonesia almost 8,000; and Pakistan, the Democratic Republic of Congo and Brazil over 5,000 each. Between 1,000 and 2,000 cases occurred in a number of African countries—Zambia, Nigeria, Congo (Brazzaville) and Mali. Large epidemics also broke out in Tanzania, Nepal and Afghanistan. During the year some 40 other countries reported smallpox including, in the Americas, Colombia, Ecuador and Peru. In Europe, smallpox invaded Sweden, Poland, Germany, Hungary and Switzerland.

But for the vigilance of health officers and their intensive efforts to confine outbreaks, the number of cases would be far, far larger, for smallpox can spread like wildfire. Even before the typical smallpox rash appears, the infected person is breathing out the smallpox virus.

Infected persons can travel and so spread the virus from country to country, sometimes before they themselves have begun to feel really ill. Last year, smallpox travelled by aircraft from south-east Asia to Sweden, from India to Poland, and from central Africa to Switzerland. It travelled by ship from Calcutta to Suez, where the health services successfully prevented it from spreading further.

CONT'D ON NEXT PAGE

UNESCO ARCHIVES

Sixty million deaths in 17th-century Europe

The disease runs its course—a matter of say three weeks. Cases range from the almost unnoticeable to the very severe. Patients die (there is as yet no specific treatment) or recover, and their recovery is of course helped by good hospital care. On most patients the disease leaves its mark —the pitted pock-marked skin, which in countries where the disease is rare may still today be regarded as a sign of evil by ignorant and superstitious people. In severe cases, the after-effects may be more serious—eyesight may be affected.

One of the dangerous facts about smallpox today is that in countries normally free of the disease few doctors have seen a case, and especially a modified case—that is, a person with partial immunity—the diagnosis of which does not occur to them.

Widespread vaccination and swift preventive measures during epidemics have freed many countries of smallpox. But the disease persists and flares up dangerously in parts of Asia, in Africa and to a lesser extent in South America —areas where efficient health services covering the whole population are only now being built up.

With the number of air passengers running to tens of millions a year, outbreaks in the developed countries now-almost invariably start with a case imported by air.

Smallpox is a world disease in that susceptibility is universal. It is a world disease also because every country is concerned with it, whether to prevent it from being imported, to limit its ravages, or to eradicate it. As long as smallpox persists **anywhere,** protective measures will be needed **everywhere.**

Unarmed against this terrible enemy in the past, man could only submit to its horrors and bemoan his fate: "Smallpox strikes everybody sooner or later. We are powerless against its might. There is no climate, no age, no sex, no temperament that is secure...".

FROM the earliest times, smallpox ravaged Asia and Africa. About 1122 B.C., under the Chou dynasty in China, the disease was already known by the name of "tai-tou", and literature mentions a very serious epidemic of smallpox in China about 200 B.C.

About 312 A.D. Rome was attacked; smallpox caused an enormous number of deaths, and played its part in accelerating the Empire's decline and fall by its paralyzing effect on social and political life.

In 675 A.D. the disease is believed to have reached Ireland where it was called "bolgach" or "galar breac," the spotted disease. Then it was the turn of Spain, where smallpox was imported by the Saracens. These warriors after having conquered the country took the disease into France and soon smallpox spread over the rest of Europe.

However, of smallpox itself little was known, and it was Abu Bakr el Razi Rhazes (865-925), the great Arab physician (see Unesco Courier, Oct. 1964, p. 33), who first gave an accurate description of the disease. Yet the great Rhazes made one mistake: he was convinced that it was normal for young infants to contract the disease; their blood, he thought, was like new wine which must ferment.

Century after century the scourge gained ground. No continent was spared. One of Cortes' negro slaves carried the disease to the Americas about 1520, during the early stages of the Spanish conquest. As a result three and a half million Mexicans died of the disease and this helped to pave the way for the conquering Spaniards. In all, about six million Indians—that is, about half the original population—died of smallpox during the Spanish penetration of America. During the conquest of North America also, smallpox decimated tribes, villages and towns; in 1633, the Indians of Massachussetts and of Narragansett numbered about 40,000—but soon only a few hundred remained.

In 1707, Iceland was ravaged by an epidemic during which 18,000 of the country's 50,000 inhabitants died. In the same year, 14,000 people succumbed to the disease in Paris. In 1721, the "Sea Horse," one of His Britannic Majesty's ships, dropped anchor in the port of Boston. There was smallpox on board. Of the town's 11,000 inhabitants, 5,984 contracted the disease and 894 died of it. Even the most inaccessible countries were not spared : in 1730, there was a severe epidemic in Greenland among the Eskimos. In 1776 in the month of June, 5,500 men of Washington's army of 10,000 fell ill, most of them with smallpox. Some historians go so far as to assert that because of smallpox Canada remained part of the British Empire. In 1770, in India, three million people died of the disease.

THE disease was so common that the scars left on the face of those who recovered were regarded as normal—so much so that in England the absence of pock marks on the face was a distinguishing feature by which an escaped criminal, for example, might be recognized. In the market places, slaves with no signs of having had smallpox were cheap, while those with large and evident scars fetched high prices since they were likely to survive longer. It was estimated that during the seventeenth century more than sixty million Europeans died of the disease.

In India, the mortality from smallpox was appalling: 500,000 persons succumbed in the years 1873-1874. At about the same time, more than 44,000 persons died of smallpox in England. In France the last serious epidemic occurred during the Franco-Prussian war and ravaged the defeated army : 200,000 soldiers were struck down by the disease and more than 25,000 of them died; at the same time, there were 200,000 cases and 18,000 deaths among the inhabitants of Paris. France at that time was the most heavily infected country in Europe.

At Montreal in 1885 a railway employee contracted the disease; smallpox was not immediately diagnosed, and it spread to 20,000 persons, of whom 3,164 died—the town's 190,000 inhabitants had been reluctant to accept vaccination. In 1893-1897, Russia was ravaged by smallpox which claimed more than 275,000 victims. At about the same time (1896-1900) there were more than 3,000 deaths from the disease in Egypt. In London, there was a serious outbreak in 1901-1902, with 6,000 cases; in order to reduce the risk of infection, the British authorities installed floating hospitals on barges and even used old warships out of commission to house the sick. The statisticians registered 36,000 deaths in Bengal from 1903 to 1907, and 54,000 cases in a single year at about the same time in North America.

In a report submitted to the Health Section of the League of Nations, Professor Tarassevich, of Moscow, cited some impressive figures: in 1919 there were 102,000 cases of smallpox in the U.S.S.R.; 1920—57,590 cases; 1921—71,605 cases; 1922—25,047 cases. The drop shown by the last figure is explained by the resumption of systematic vaccination.

Throughout the ages man sought some way to protect himself. Some medical historians like to think that anti-smallpox inoculation is as old as the disease itself. In the remotest times, in fact, physicians noted that people who had recovered from smallpox were protected in some way against a new attack.

In China and India, it was observed that the disease produced pustules of varying gravity. The idea arose of

WHO

WORLD-WIDE THREAT. No country is free from the threat of smallpox. If health authorities were not constantly on the alert, smallpox could spread like wildfire. Under international sanitary regulations, countries must notify cases to WHO within 24 hours. Here, infected areas are being recorded.

transferring a mild infection to healthy persons in order to protect them against a serious attack. The Chinese method consisted in blowing powder made from the scabs of pustules into the nostrils of the person to be immunized, through a copper tube. In India, pus from mild smallpox pustules was introduced into the skin of the elbow of the person to be protected. In short, a kind of preventive smallpox infection was applied. The practice it was known in 1715. In 1716, Pastor Cotton Mather in Boston learned from his negro slave, who came from the Fezzan, that smallpox inoculation was widely practised in Africa. In Europe generally, however, the method made but slow progress.

In Turkey, at the beginning of the eighteenth century, smallpox inoculation was being practised. Lady Mary Wortley Montagu, the wife of the British Ambassador to Turkey, got to know about this method of prevention.

Lady Mary, a determined woman, was quickly convinced and did not hesitate to have her three-year-old son inoculated. In a letter to one of her friends she gave some interesting facts concerning the technique of the operation:

"A propos of distempers, I am going to tell you a thing that will make you wish yourself here. The smallpox, so fatal, and so general amongst us, is here entirely harmless, by the invention of ingrafting, which is the term they give it. There is a set of old women, who make it their business to perform the operation, every autumn in the month of September, when the great heat is abated.

"People send to one another to know if any of their family has a mind to have the smallpox; they make parties for this purpose, and when they are met (commonly fifteen or sixteen together), the old woman comes with a nutshell full of the matter of the best sort of smallpox, and asks what vein you please to have opened.

"She immediately rips open that you offer her, with a large needle (which gives you no more pain than a common scratch) and puts into the vein, as much matter as can lie upon the head of her needle, and after that binds up the little wound with a hollow bit of shell ; and in this manner opens four or five veins . . .

"The children or young patients play together all the rest of the day, and are in perfect health to the eighth. Then the fever begins to seize them, and they keep their beds two days, very seldom three. They have very rarely above twenty or thirty pocks in their faces, which never mark, and in eight days they are as well as before their illness."

This was how smallpox inoculation was practised in Constantinople. For adults also the effects were mild: eight days' incubation, two to three days of malaise, and no scars after recovery.

When she returned to England in 1718 Lady Mary's one thought was to promote smallpox inoculation. In 1721, she took a spectacular decision and had her daughter publicly inoculated in the presence of the Court physicians. The successful operation caused such a sensation that Caroline of Anspach, the Princess of Wales, who herself had had smallpox at the age of three, became one of Lady Montagu's most enthusiastic supporters.

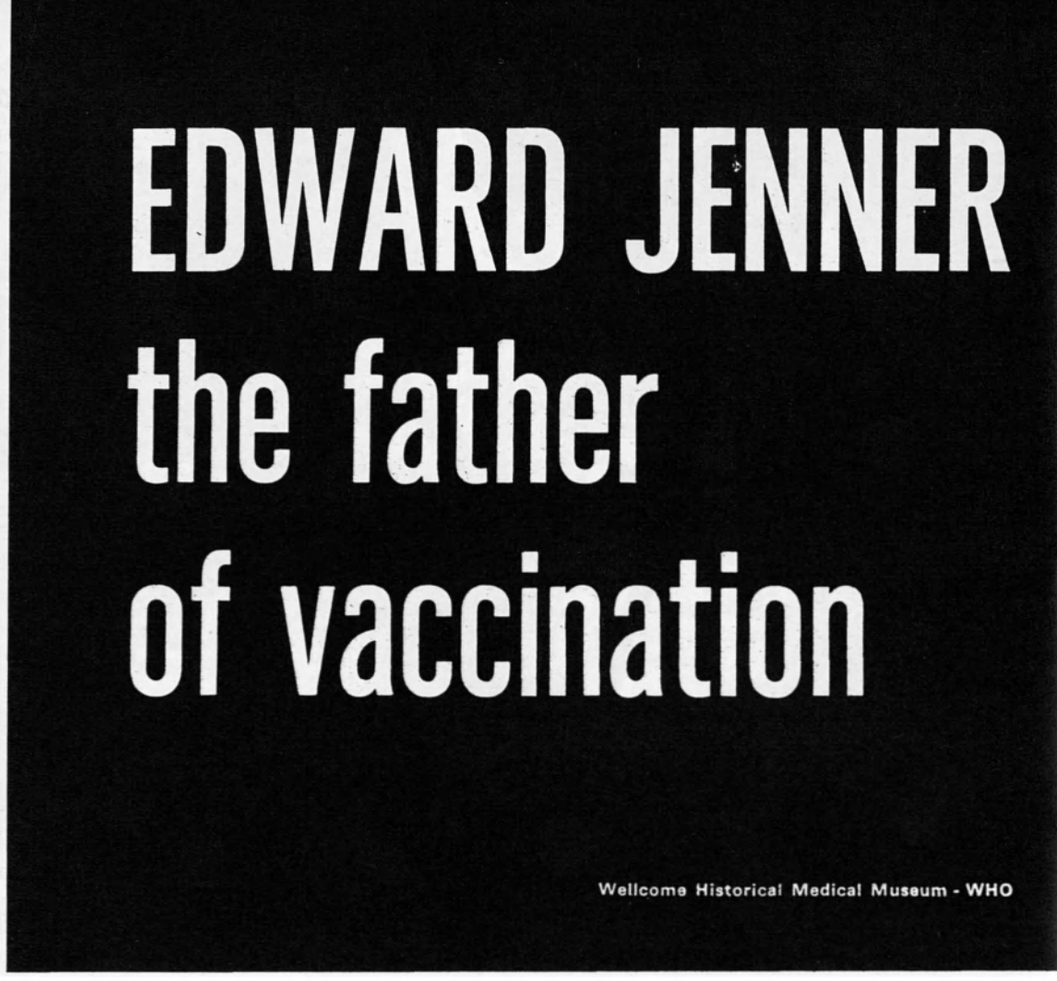
It was decided in the same year to carry out an experiment on six condemned prisoners at Newgate. The experiment began on August 9 and ended on August 31 with the release of all the prisoners, who were pardoned and sent home after having undergone the inoculation with success. Posterity is therefore indebted to Lady Mary Wortley Montagu for her intelligent and courageous action and she deserves recognition as the forerunner in England of Edward Jenner in the fight against smallpox.

There is no doubt that inoculation was a step in the right direction. The technique was simplified later , the arm-to-arm method of inoculation was introduced, using persons suffering from a slight attack of the disease ; but there was a considerable element of danger in this operation and sometimes serious symptoms would follow in the inoculated person. There was yet another factor: every inoculated person was a potential new focus of infection—far from being reduced, the disease was thus maintained and even disseminated.

Only with the introduction of the Jenner method of vaccination was the way found to protect the individual as well as the community.

EDWARD JENNER the father of vaccination

In 1796 Edward Jenner, an English doctor, carried out the world's first vaccination, thereby discovering how to produce immunity against smallpox. We present here the story of Jenner's patient search for a way to defend man against a disease that had plagued him throughout history.



Wellcome Historical Medical Museum - WHO

AS a student he was rather dreamy, but also gifted with great imagination. There was a poetic streak in him and he loved nature and the English countryside of the 1770's. This 21-year-old Englishman was the third son of the Vicar of Berkeley in Gloucestershire. For eight years already he had been apprenticed to a surgeon apothecary, Daniel Ludlow of Sodbury, near Bristol. The young man's name was Edward Jenner.

One morning during consulting hours a young country girl came to see him. Like any other doctor he asked her a number of questions and wanted to know whether she had been ill before. Yes, she said, she had had the cowpox and this was just as well, she added, for it would protect her against the smallpox: "I cannot take that disease for I have had cowpox".

Jenner's curiosity was aroused. He had of course been taught the technique of inoculation like all medical students of his day and was familiar with this means of protection against smallpox, but he realized that it was not perfect. In London, in Jenner's early days, smallpox killed one to three thousand persons every year. Jenner came from a country district where the belief was fairly widespread that cowpox, an infection of the udder transmissible to man, would protect the person who got it against smallpox.

Jenner practised smallpox inoculations but the scientist in him suspected that improvements were possible. Analysing the results of his inoculations critically he realized that most of the unsuccessful inoculations—those that did not "take"—occurred among persons who looked after animals and who previously had had cowpox. This obviously called for further investigation.

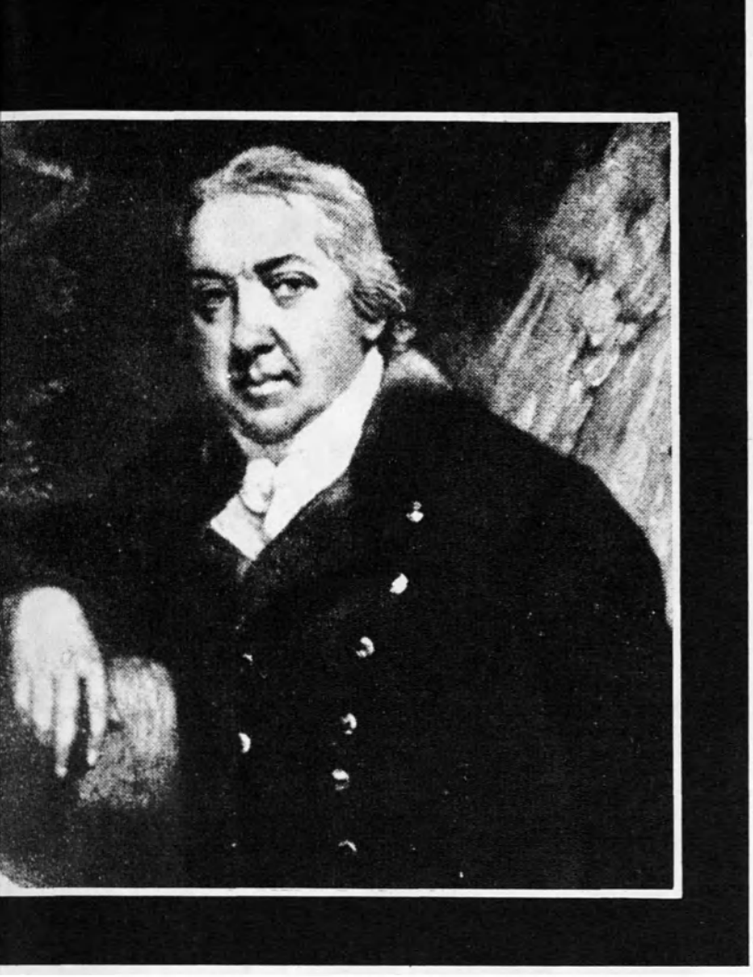
Leaving Sodbury, the young man spent two years in London as a resident house pupil with Dr. John Hunter, the distinguished surgeon and medical researcher, at St. George's Hospital. His ambition was to set up practice in surgery and pharmacy at Berkeley. Before leaving Hunter he wished to know what the great man thought about inoculation. Was this technique not outmoded? Could something better be found? Hunter's advice was: "Don't think, Jenner, but try experiments".

Cowpox protects against smallpox—this idea obsessed the young doctor of Berkeley. But proof was needed. Opportunity offered it in the shape of a milkmaid, Sarah Nelmes, and James Phipps, a boy of about eight years. Sarah had developed a cowpox sore on her right hand. The sore appeared so typical to Jenner that he had a drawing of her hand made. Two other small pustules on her wrist, he was convinced, were also due to cowpox. If the matter in the pustules was really active, he argued, then it should have its effect also on a child who had neither had smallpox nor cowpox. So on May 14, 1796 he made two superficial incisions in the arm of James Phipps and inserted some of the liquid from Sarah's large pustule. In this way he hoped to protect the child against smallpox.

Seriously, carefully, he followed up the results of his operation. At first there was almost no reaction and the incision marks practically disappeared, but then, when everything seemed to be over, the skin where the insertions had been made became red and slowly swelled up; a sore appeared and grew. The boy felt quite well until the seventh day when he had a slight pain under the arm. On the eighth or ninth day he had some fever, shivered a little, lost his appetite and had a slight headache. Throughout the day he felt slightly ill and that night he slept badly. But the next day the boy was quite well again.

Neither Jenner nor his patient was the least bit worried by the remaining scabs. Jenner was happy with the result. The reaction had not been serious—a little fever, a passing indisposition, and no complications. But of course that was only half the story. What would the future bring? Would James Phipps escape smallpox?

Edward Jenner wanted to be sure. In July he faced the cardinal test and inoculated the boy with matter taken straight from a smallpox pustule. What would be the outcome? Jenner was worried. He could not sleep, got up at night and walked up and down in the consulting room in



his comfortable house at Berkeley. What if he had made a mistake?

Time dragged heavily. Again he meticulously observed every phase of the reaction. But the days went by and it was not long before all trace of the vaccination disappeared. Young Phipps did not get the fever, nor any infectious symptom. He seemed indeed to be resistant to smallpox: the animal disease had immunized him. So, for Jenner, the decisive experiment had been performed and henceforth he was sure of the protective value of cowpox. Jenner was so overjoyed that he treated James Phipps as his son. Later, in 1818, he even had a house built for the young man, the first person he vaccinated.

THE advent of smallpox vaccination was the opening of a great chapter in the history of world medicine. But Jenner realized that not everybody would be convinced by his method so he pursued his studies and repeated his experiments. It was not until 1798 that he decided to publish his findings in a little work of 60 pages entitled "An inquiry into the causes and effects of the variolae vaccinae". His ideas, however, were received rather sceptically at first.

Jenner spent three months in London. He was in the prime of life and his friend, Edward Gardner, left the following description of him: "He was rather under middle-size, but robust, active, and well formed. He was particular in his dress, and when I first met him, he was clad in a blue coat with yellow buttons, buckskins, well polished jockey-boots with handsome silver spurs, and carried a smart whip with a silver handle. His hair, after the fashion of the time, was done up in a club, and he wore a broad-brimmed hat."

But the elegant Jenner looked in vain for volunteers on which to try out his vaccination. There were numerous supporters of the old method of inoculation who tried to cover him with ridicule and made fun of his method which, they said, the doctor had simply got from a milkmaid. The public showed strong opposition. The clergy even spoke of vaccination as a kind of plot against the designs of the Lord. In fact, there were vested interests at stake and Jenner's method was opposed by inoculation "specialists". The opposition did not hesitate to imply that Jenner was an unscrupulous fellow who was out to make a fortune by championing an ineffective method of treatment.

Matters became worse because Jenner was highly sensitive to criticism, could not put up with disagreement and was rude to people who did not embrace his view. However, after a good many tests and countertests, all of which were successful, the wind started to turn. The simplicity of the operation also proved to be a good argument. It became increasingly difficult for the opponents to argue their case, especially after Pearson and Woodville, two prominent figures in British medicine, had confirmed Jenner's results.

But something was wrong after all. Jenner and his followers made the mistake of basing part of their argument on the assumption that vaccination conferred lasting immunity. This gave rise to some hesitation among English doctors who, while supporting the principle of vaccination, stressed the necessity for re-vaccination. At this point of the controversy the promoters of vaccination showed themselves to be too conservative. They were against re-vaccination, not because they thought it would be altogether useless, but rather for fear of discrediting their method and of weakening the confidence of the public. The public, of course, was only too easily put off by clumsy vaccinations and occasional severe reactions.

WHAT really counted was that the movement had started and it could not be reversed. Despite objections, it spread to many parts of the world. Benjamin Waterhouse vaccinated in Boston though he complained that the public was uninterested and suspicious. Seaman vaccinated in New York; Coxe, Rush, Oliver and Currie in Philadelphia, and James Smith in Baltimore. In Hanover, Germany, Stromeyer also complained of the opposition of his colleagues. Another vaccinator, Stuve at Görlitz, said he had many enemies and that his fellow doctors were jealous of him. In France, there was propaganda against the vaccinators, but it did not go very far. In 1800, Woodville took vaccine to France and taught his French colleagues the new method.

But Jenner was not to be satisfied with all this. Now that he had determined the protective power of cowpox, nothing would do but for vaccination to be practised everywhere. He had set himself the task of protecting the whole of mankind against smallpox.

General immunization, he was convinced, could only be achieved through cowpox. But the pustules on the cow did not last very long and they contained too little matter for widespread use. Furthermore, sick cows were not always to be had and it was out of the question to spread cowpox among healthy animals. Jenner considered that the sore produced in man was so like the cowpox sore that the artificially produced sore could render the same services as the original one. In other words, since the supply of matter from cows was limited he would create another such pustule in the next person. In this way, an uninterrupted chain of solidarity against the disease might be created. Jenner's obstinacy in experimenting this system was to have its reward and he succeeded in continuing this person-to-person vaccination for a period of 14 months without apparent loss of efficacy. He claimed that, after all these passages, the vaccine was just as effective as if it had been taken straight from a cow.

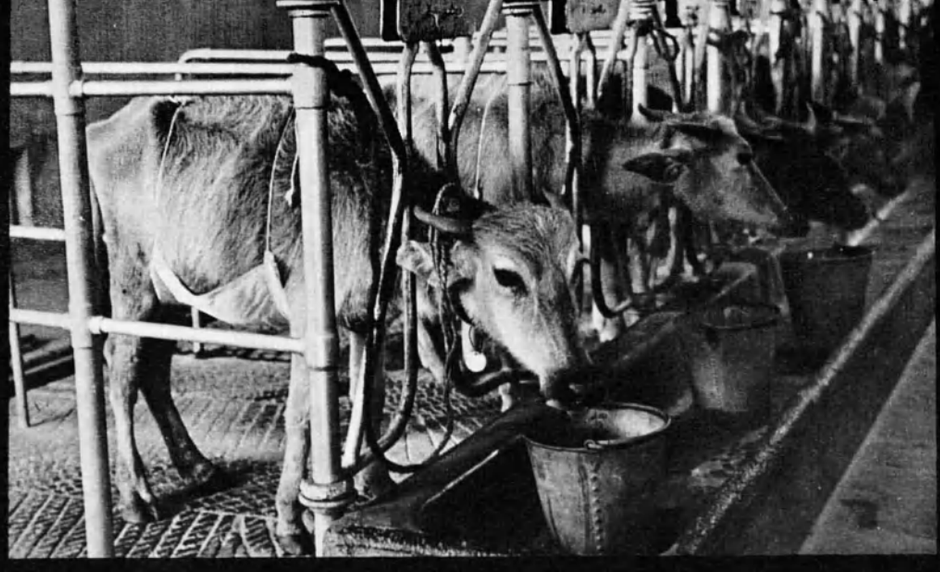
Sure of himself, Jenner continued his demonstrations, countered every objection, and decided to carry the battle to London. He set up house in Bond Street. Two years

CONT'D ON NEXT PAGE

A ton of prevention...

How to prevent smallpox through vaccination has been known since the end of the 18th century. Yet the disease remains endemic in many Asian and African countries and is still not completely eliminated in Latin America. The aim of an eradication campaign is to vaccinate 100 per cent of the population in countries where the disease is prevalent. For this, enormous stocks of vaccine are needed. In India, where 250 million people (out of 450 million) were vaccinated between 1962 and 1964, vaccine is being produced with assistance from WHO and UNICEF. At the King Institute of Preventative Medicine in Madras, vaccine is prepared from virus grown on the abdomen of calves (top right). Freeze drying of this vaccine (bottom and opposite page) produces a stable product which can be stored successfully in India's tropical climate.

WHO photos P.N. Sharma



JENNER *(Cont'd)*

A baby christened Vaccinov

later, his technique had been adopted by 40 doctors who became enthusiastic supporters of the new method. In 1800, as many as 16,000 Londoners were vaccinated. In 1801, the number rose to 60,000.

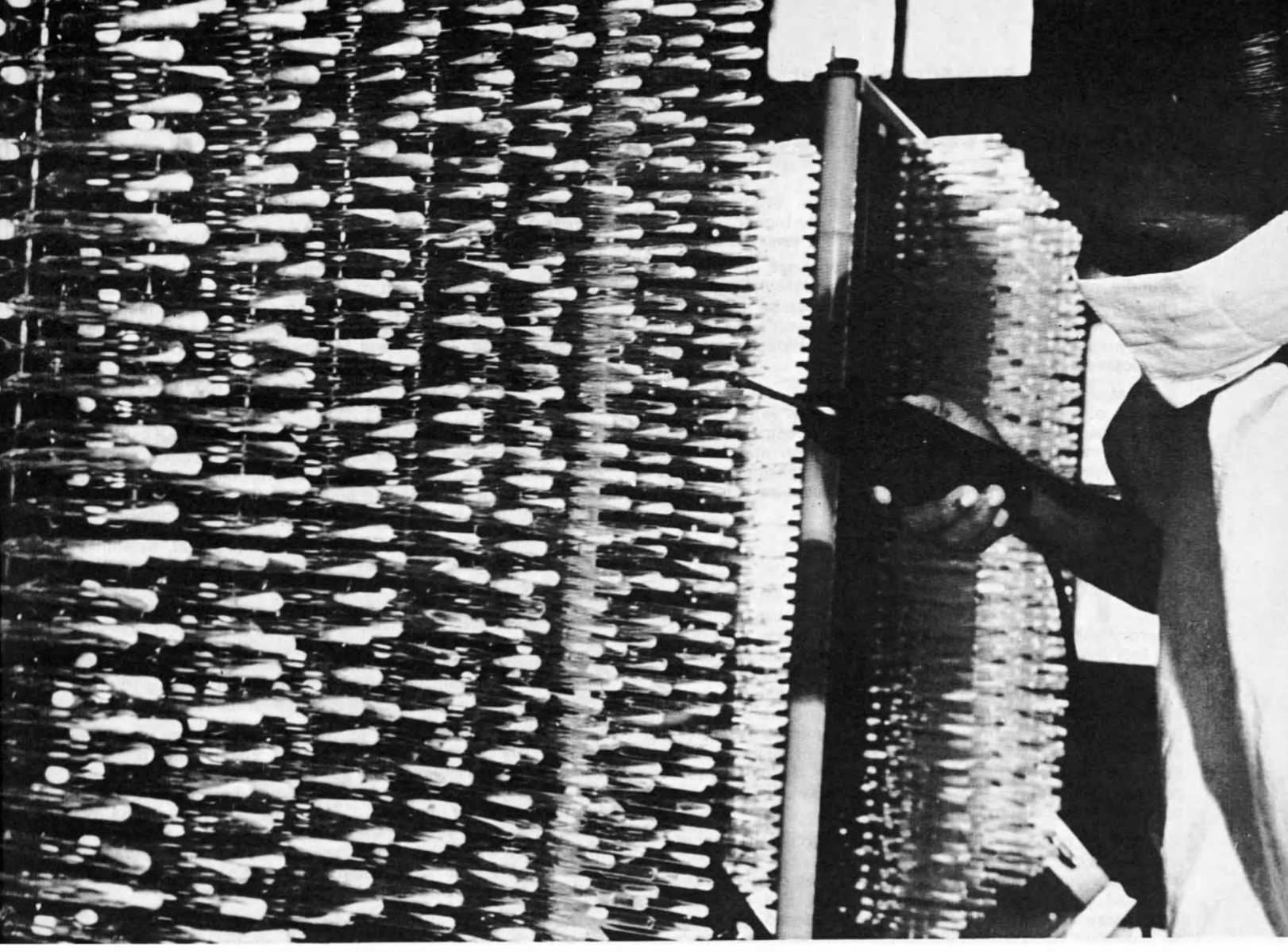
News of victory came from abroad. In the United States, Waterhouse was supported in his efforts by a propagandist of choice: Thomas Jefferson in person, who had his entire family vaccinated.

The Geneva doctors also were in the van; Dr Odier obtained vaccine from England and was able to vaccinate over 600 persons at the very time an epidemic of smallpox had broken out. Nevertheless, the epidemic caused 254 deaths. His colleague, Alexandre Marcet, invented a way of preserving the vaccine between two slides of opaque glass wrapped in black paper.

Another Genevan, Jean de Carro, had the honour of being the first and greatest propagandist for vaccination outside Britain. He had established himself in Austria and was won over by Jenner's method about which he had read in a local paper. He did not hesitate to vaccinate his two sons and soon after submitted them to the countertest in the presence of Austrian doctors. After this convincing demonstration, smallpox vaccination was adopted throughout Austria and Germany. As a reward, he was knighted by the Emperor Francis II. Thanks to his enthusiasm, vaccination soon spread to Poland and Russia. In St. Petersburg, the royal surgeon de Lyndström made good use of the vaccine sent by de Carro. Elisabeth Alexevievna, Empress of all the Russians and wife of Alexander I, was so enthusiastic that she not only sent Jenner a ring with a large diamond but encouraged mass vaccination. At her command, Anton Petrov, the first child to be vaccinated in the Empire, was escorted in a coach through St. Petersburg to be baptized. and was given the new name of Vaccinov. The State paid for his upbringing and later granted him a pension for life.

Carro, knowing that Jenner was trying to introduce the vaccine in India, developed a new method of preservation. The vaccine was dried on threads and pieces of ivory, which were then enclosed in a wooden box as protection against light. Using this method Carro sent the vaccine to the British Consul in Baghdad. His initiative was crowned with success: vaccinations were performed at Basra on the Persian Gulf and soon in Bombay. Jenner was so happy that he sent his friend a silver snuff box with the inscription "Edward Jenner to Jean de Carro".

The vaccine was spreading. Dom Balmis, surgeon to King Charles IV of Spain, brought it—together with 22



children needed for person-to-person transmission—from La Coruna in Spain to the Canary Islands, to the Caribbean, to Mexico, to Guatemala and to South America. Then, with 26 other children, he went to the Philippines and China. At Naples and in Sicily, fervent religious processions were held to fetch the vaccine prepared by Dr Sacco—the new method was almost credited with sacred power. In France, Bonaparte, First Consul, admired Jenner's efforts and officially encouraged vaccination. The year after he became Emperor, he made vaccination compulsory for all his soldiers.

One day, when he was about to set off again for the wars, he was listening absent-mindedly in the presence of the Empress Josephine to the reading of a letter requesting the liberation of an English prisoner and was about to say no when Josephine remarked "But it's Jenner who is making the request". Napoleon immediately changed his mind: "Ah, Jenner! I can refuse nothing to Jenner."

The merit of having been the first head of state to decree compulsory vaccination for all subjects goes to Felix Pascal Bacciochi, Prince of Lucca and Piombino. His decree is dated 1806. His example was followed by Bavaria the following year, then by Denmark in 1810, by Sweden in 1816, and by Wurttemberg in 1818, where the King ordered every infant to be vaccinated before the age of three.

Jenner subsequently led a somewhat secluded life in his country house in Berkeley. He could now consider that he had reached the goal he had set himself. Vaccination was spreading with irresistible force. He spent many hours alone working at the bottom of his garden in a summer house which he had specially built. There he also pursued his favourite pastime, birdwatching. On an appointed day he still received all those who wished to be vaccinated, in the summer house, which he called his Vaccina Temple.

Sure of his achievement, proud of the wide appreciation his discovery had received, he continued to correspond with men of learning up to the time of his death, which occurred as he sat at his writing table, on January 26, 1823.

For long, however, smallpox vaccination was to have its enemies. Some of them were important figures who did their best to play on the fears of the public. For example, in 1855, a work was published in Paris by Verdi-Delisle entitled "The Physical and Moral Degeneration of the Human Race caused by the Vaccine". In 1890, Alfred Russell Wallace, "in the name of individual liberty", joined the detractors and fought the idea of legislation that would make vaccination compulsory and non-compliance punishable by fines or imprisonment. Bernard Shaw himself swelled the ranks of the opponents with his play, "The Doctor's Dilemma."

All the arguments of the doubters, detractors and opponents, however, lost ground against the favourable conclusions of the official reports on vaccination that gradually accumulated: 1882 in Germany, 1885 and 1896 in England, and 1913 in Pennsylvania, for example.

Jenner's discovery was first accepted and then advocated in many places all over the world. As a mass preventive measure, it soon changed the face of smallpox—epidemics became less frequent and less serious. Jenner's tenacity, maintained during 26 long years of struggle, was at last bearing fruit.

An uninterrupted creative process

we see that money spent on education (approximately 2-3 thousand millions), can yield far higher returns (approximately 70 thousand millions) in a few years' time.

If education is to be made more efficient, it must be soundly planned. Social, economic, demographic, geographic, organizational and other factors must be taken into account in educational planning. In other words it must be closely related to overall planning of national economic development.

Great importance attaches to the social and economic aspects of the question. The very nature of work is being transformed as a result of changes in industrial relations and the increasing degree of mechanization and automation of production. Industry today increasingly needs highly trained workers, and technical education must meet this need.

THE experience gained by the Soviet Union and certain other countries in the elimination of illiteracy and the rapid development of education underlines the fact that reading, writing and arithmetic must be taught initially in the pupil's mother tongue. The problem of creating a written form for each language and teaching primary school pupils in their mother tongue is therefore immensely important for the young, developing countries. A revision of teaching programmes and a full use of technical aids can not only contribute to the further development of primary, secondary and higher education, but also to campaigns for adult literacy.

Problems arising in relation to education and scientific and technical development cannot possibly be solved unless serious attention is paid to the training of scientists and other specialists in each nation. Every developing country must have its own national scientific centres—an academy of sciences or scientific councils—and also a network of scientific research institutes to serve the main fields of economic and cultural development. Unesco should furnish the developing countries effective assistance in creating a national and regional framework for the development of science.

Unesco's social sciences programme frequently comes under discussion. The best way to increase the effectiveness of activities and research work in the social sciences, it seems to me, would be to reveal the tremendous possibilities which general and complete disarmament could open up for the development of education, science and culture.

We have only to consider the scale of the resources needed for financing educational programmes and for training technicians in all countries—especially the developing countries—to realize what immense possibilities the achievement of disarmament would bring. Studies of the social, economic, cultural, scientific and technical consequences of disarmament; an investigation of ways to remove the effects of colonialism in developing countries; a stepping up of the campaign against racial prejudice and discrimination; efforts to foster greater mutual understanding of different ideas, methods and principles—all this would help Unesco to solve problems assigned to it by its Constitution.

Works of art are of value only if they bring happiness and if they help people to live richer lives and to judge world history and world events correctly. This, to a great extent, is why the works of the great masters of the past have achieved immortality. Let us take the example of the Venus of Milo. Greek by origin, Parisian by residence, triumphantly touring from continent to continent, she has become a citizen of the world. Or, as another, take Eisenstein's film, "The Battleship Potemkin," which has been winning acclaim in many countries for several decades. The same will probably be true of the film "West Side Story."

Every people has its favourite writers, artists and composers. The works of literature and art that have won the esteem and affection of a people become the heritage of all mankind. Surely this is borne out by the fact that the works of Michelangelo and Shakespeare, Rembrandt and Beethoven, Tagore and Maxim Gorky, Rodin and Mark Twain, give joy and delight to all nations of the world. And what enjoyment we derive from the still too little known cultural heritage of Africa and Latin America.

Unesco would fulfil its role better if it used all the means at its disposal to ensure that the cultural values of mankind were instrumental in furthering humanistic principles, and in spreading and strengthening the concepts of peace, friendship and international understanding.

The future of the whole world and the social, scientific and technological progress of mankind depend on the education of our young generation. Peace would be in mortal danger if racial prejudice and revengeful and militaristic ideas were to triumph. The education of the younger generation in the spirit of mutual understanding, peace and friendship among nations, regardless of national differences and political and religious convictions is therefore the sacred duty of Unesco and of us all.

A realistic assessment of the world in which we live reveals the existence of economic, social and political contradictions. However, the use of force to settle problems can no longer be localized—it will have dire consequences for the whole of mankind. Therefore the repudiation of force in settling problems and the subsequent application of a policy of economic, cultural, scientific and technological collaboration and peaceful coexistence, are the right path to be followed in relations among nations.

The peoples of all countries should make every effort to achieve the complete cessation of all types of tests of atomic weapons and to achieve general and complete disarmament and the strengthening of economic, cultural and scientific collaboration among countries with different social systems in the name of the progress of all mankind.

VIEWED in the light of social, scientific and technological progress, the satisfaction for all time of the food and energy requirements of mankind, the elimination of infectious illnesses, the conquest of cardiovascular diseases and cancer, the consequent achievement of unprecedented longevity and a happier life than has yet been known, and an unparalleled flowering of education, science and culture now begin to appear real and close at hand.

By its very nature and substance life is a contradictory, an optimistic affair. It is the result of an uninterrupted and stupendous creative process. We must all labour incessantly to extend this process and to implant humanistic principles more firmly in mankind while striving to remove all obstacles that lie in the way.

Until now, it has always been considered normal that an organism should age with the passing of time; this was held to be a natural law. But man, armed with science and the principles of humanism, is triumphing over this natural phenomenon.

Unesco does not age with the years, for young states are constantly joining it, its working methods are being perfected, and its work is bearing fruit. May I express my firm belief that our Organization will take an increasing part in achieving the noblest aims of our age—the strengthening of peace and of fruitful collaboration in the field of education, science and culture.

Letters to the Editor

WORLD SIDE STORY

Sir,

I came across Professor Kvaraceus' articles on juvenile delinquency, World Side Story (May, June and September 1964) not in my capacity as a schoolmaster, but as a leader of a youth club.

It can be argued that what young people need in a youth club is no rules and few, if any, organized activities. We have rules—some of them of the "Thou shalt not" type—but in general this does not turn too many away. As to organized activities, there have been times when some of the members have been unwilling to participate; yet when there are no such activities planned there are complaints of "nothing to do". I ought to add that we have a committee of members responsible, to some extent for planning the programme.

On the one hand these teenagers want to rebel (albeit mildly) against rules and organization; on the other hand they feel somewhat lost if there is no authority and are prepared to accept what rules we have.

The committee illustrates their desire to have themselves as their own authority, but also their inability as yet to take full responsibility: they are still willing enough for us to organize things when they cannot.

I agree wholeheartedly with Professor Kvaraceus that the whole problem of juvenile delinquency is extremely complex and consequently any solution must be just as complex. I dislike superficial analyses which state that the real key to the problem is X and so the answer is Y. Similar are attempts to classify teenagers into a few categories and then to rigidly apply a set of rules to each class. They are individuals and have to be treated as such. The problem of juvenile delinquency is surely as complex as the number of individuals caught up in it. We hope that our youth club activities and atmosphere, though both limited, do in fact help some teenagers to be, at least, better citizens of our society than they would have been otherwise.

R. Tyler
Coulsdon, Surrey, U.K.

Sir,

After reading and re-reading the World Side Story articles, I felt that some essential element was still missing. I agree entirely with the author that parents bear much responsibility for defaults in the education of young people. But there is something else which could explain inertia in parents and social inadaptation among youth. The author refers several times to "insecurity", but fails to develop the idea. This, to me, is a point to be stressed. What does our present epoch offer to the young people who will be tomorrow's adults? The atom bomb—nothing more, nothing better.

We all realize that we may become the victims of some act of imprudence or negligence or even of a mistake on someone's part. But we who have lived for some time have known less disquieting periods; today's young people have always lived under an omnipresent threat. I believe this is the real reason for today's juvenile delinquency and for many other symptoms of decadence.

M. Launay
Andenos-les-Bains, France

Sir,

I would list the chief causes of juvenile delinquency as follows: (1) an excessively highly-strung nature and an insufficient or badly-chosen diet, i.e. above all a question of health (2) deprivation of affection (3) insecurity in the family circle (4) "broken" homes or quarrelling parents (5) a lack of care, order and cleanliness.

Ethics should be taught to children at the earliest age by properly trained and experienced teachers who are themselves fond of children.

Mme Govaerts-Rouvroy
Malines, Belgium

Sir,

I disagree completely with certain ideas in World Side Story. Nowadays we pay far too much attention to young people, or rather, to their problems. These are not real problems, being of a transitory kind, and are certainly not adult problems. I am, however, in favour of youth movements and sporting, cultural and welfare associations whose basic aim is the moulding of character. But when young people are always hearing about their problems they tend to get an exaggerated idea of their own importance and this encourages them to seek freedom prematurely. Aside from this I found the articles extremely interesting; they helped to clarify my ideas on the subject.

Claude Rollet
Grenoble, France

Sir,

I would like to say that society gets exactly what it appreciates or rewards. A child wants to become important in a good way. But if overstrict parents or authorities do not appreciate and encourage him when he does something good, then the only way to get attention is for him to be bad, so that at least he can get a negative form of love. Overstrict parents are the cause of more human misery than can be catalogued in any single volume.

Arthur J. Johnson
Chicago, Illinois, U.S.A.

HELPFUL MAPS

Sir,

The Courier gives an illuminating picture of the world and its diverse peoples. This is a function that Unesco is uniquely suited to perform.

I should like to see, with each article, a map which would give some idea of the area or areas mentioned in the text. As an American who has not travelled extensively throughout the world it is often difficult for me to transport myself to regions elsewhere which are not frequently mentioned in the daily press. The maps accompanying "People of the Deltas" by Adriaan Volker, (July/August 1964 issue) is an excellent example of what I mean. This would increase the informative value of The Courier for myself and others like me.

Joseph Bernstein
Gardena, California, U.S.A.

WOMEN IN THE NEW ASIA

Sir,

Thank you for the splendid issue on Women in the New Asia (September 1964). Being a woman it was natural that I should find it of greater interest than some of the issues dealing with more technical subjects.

It is good to learn of the opportunities that are being given to the women of Asia and may we hope that they will use these opportunities to greater advantage than do many women of our own country who have enjoyed them for many years.

I hope in the near future Unesco will give us a similar issue on "Women of Africa". I have travelled in Africa but have seen only slight evidence of change of status for the women of these countries.

In Egypt my hopes revived when I saw a group of women in the oldest mosque in Cairo. Here they were being taught to read and write and given a knowledge of hygiene and the care of children. The Egyptians believe that much can be done through the influence of the woman on her family. This I believe is true for the women of the whole world.

Ivy Crowson
Newcastle upon Tyne, U.K.

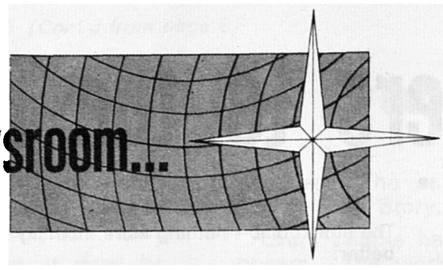
Sir,

The personal accounts in "Women in the New Asia" no doubt bear witness to a striking evolution, but they only apply to the emancipation of young women from well-to-do families. You might thus be accused of saying nothing about the position of women in less prosperous families.

However, I am sure the issue will inspire everyone to reflect on the problem and this is a worthwhile result as I strongly doubt whether many people, even in so-called "civilized" places, concede to women their rightful place.

Louis Henin
Le Havre, France

From the Unesco Newsroom...



UNESCO'S PROGRAMME FOR 1965-66

UNESCO has now embarked on the world programme in science, education and culture which it proposes to carry out in 1965-66. To finance this programme, adopted by the Unesco General Conference at the end of last year, Unesco's member states are contributing nearly $49 million—almost $10 million more than in 1963-64. During the next two years Unesco also expects to use a further $50 million, provided by the U.N. Special Fund and the U.N. Expanded Technical Assistance Programme to carry out operations in member states at their request.

The programme envisaged by Unesco was debated and approved by delegates from 117 member states, who included 64 ministers, 80 scientists and 150 specialists in educational and cultural affairs. Here are some of its salient features:

● Education, as a key factor in economic and social development, is given continuing priority and has been allocated nearly one-quarter of Unesco's regular budget. Special emphasis is given to educational planning, for which Unesco set up an international institute in Paris in 1963, and to a world attack on illiteracy.

● The outstanding feature of Unesco's new campaigns against illiteracy is the special experimental programme for mass literacy to be carried out in eight countries as a preparatory step to the launching at a later stage of a world literacy campaign (see Unesco Courier, Oct. 1964). Ways and means of eradicating what Mr. René Maheu, Director-General of Unesco, has called "the scandal and shame" of illiteracy, will be worked out at an international congress to be held in Teheran in September of this year at the invitation of the Shah of Iran. As a result of the Unesco International Youth Conference in Grenoble, France, last year, an International Committee on Youth is being set up. It will work with Unesco to promote youth activities for international co-operation and understanding.

● Priority is accorded to science on an equal footing with education. Unesco has reshaped its science programme and is using a large proportion of its science budget for projects related to science and technology for economic development.

● Unesco projects, designed to "plant the tree of science" in developing areas, will assist the training of engineers and the expansion of technological research, as well as the creation, in collaboration with leading universities, of an international network of refresher courses for scientists.

● January 1965 marked the start of the International Hydrological Decade launched by Unesco. This co-operative international scientific venture seeks to improve water management throughout the world, to develop hydrological knowledge and to encourage increased training for scientists in this field (see Unesco Courier, "Water and Life," July-August, 1964).

● A unique service of S.O.S. earthquake teams has been created by Unesco. These reconnaissance missions will be sent within 72 hours to the scene of severe earthquakes. This is one of the innovations in Unesco's programme on seismology and earthquake engineering which also provides for the mapping of seismic danger zones, research on earthquake prediction, research into protective measures against earthquakes and the extension of seismological observatories (see Unesco Courier, Oct. 1963). Other studies and projects will be carried out in geology, the life sciences and oceanography, in which Unesco has already promoted important international surveys covering the Indian Ocean and, more recently, the tropical Atlantic.

● Unesco is continuing to promote the growth of press, radio, films and television in the developing countries and the training of technicians to work in these fields. It is also encouraging the use of mass media for adult education and literacy campaigns.

● A six-year project, now operating in Senegal, Africa, provides a field laboratory for Unesco and its African member states to test the effectiveness of radio, television, films and publications as aids for adult education.

● Broadcasting via space communication opens up tremendous possibilities for teaching vast new audiences and therefore directly interests Unesco as a means of promoting the flow of information, the spread of education and wider cultural exchanges. This year Unesco will be co-operating closely in this field with the International Telecommunications Union.

● Unesco is devoting increasing attention to the social and cultural aspects of economic development, especially on the impact it makes on recently independent countries. Other major problems being dealt with under its programme in the the social and human sciences are the struggle against race prejudice and the economic and social consequences of disarmament and peace research (see Unesco Courier, Nov. 1964).

● Unesco's 10-year Major Project on Mutual Appreciation of Eastern and Western Cultural Values as such is scheduled to end in 1966 when its effects will be carefully analyzed. Unesco's efforts to promote understanding between different cultures will, of course, continue and will be extended to include African cultures. In this context Unesco is to prepare a "General History of Africa" which will complement another major Unesco-sponsored historical work, "The History of the Scientific and Cultural Development of Mankind", the second volume of which is due to appear in May (*).

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For further facts we refer readers to Unesco's Official monthly publication, "The Unesco Chronicle", whose January 1965 issue is entirely devoted to the decisions of the 13th Session of Unesco's General Conference. Published in English, French, Spanish and Arabic editions, it can be obtained from Unesco National Distributors (see inside back cover). Annual subscription: $2.00; 10/-; 7 F.

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* Volume II. The Ancient World, appearing in three parts: (1) From about 1200 B.C. to 500 B.C. (2) From about 500 B.C. to the Christian Era. (3) From the beginning of the Christian Era to 500 A.D., published by George Allen and Unwin Ltd., London (Price £6.6 0.) and by Harper and Row, New York.

'TIMELESS TREASURE'

A new Unesco film on monuments in peril

IN all parts of the world works of art and monuments are threatened with destruction by time and nature and, increasingly, by man himself. A new Unesco film entitled, "Timeless Treasure" warns how close the world stands to losing forever these unique vestiges of its past. It shows the marks left on the face of mankind's irreplaceable historical records by erosion, neglect and vandalism. The film also reveals what is now being done to save monuments and works of art. Some of the work of protection and preservation is described by Dr. J. Harold Plenderleith, director of the International Study Centre for the Restoration and Preservation of Cultural Property, set up by Unesco in Rome. Dr. Plenderleith was a contributor (The New Science of Art Conservation) to the special issue of the Unesco Courier on Monuments in Peril (January 1965).

"Timeless Treasure" (running time 27 minutes, black and white, 16 mm. and 35 mm.) exists in English, French and Spanish versions; a Russian version is being prepared. Copies can be obtained by writing to the Radio and Visual Information Division Unesco, Place de Fontenoy, Paris (7e).

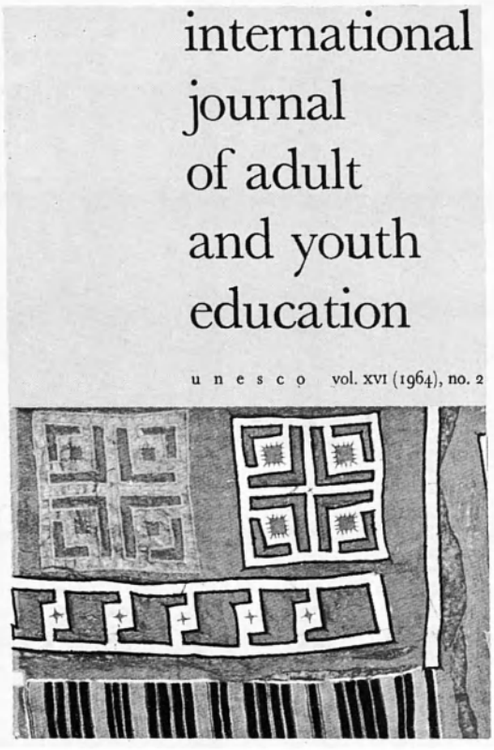
Imp. GEORGES LANG, PARIS. IMPRIMÉ EN FRANCE.

Museum, a quarterly review of activities and research in the field of museography, is produced not only for those professionally interested in the running of museums, but also for teachers and students of art in general. Lavishly illustrated and printed entirely on art paper, it reports on outstanding achievements in display and conservation, presents new examples of museum construction and describes what museums are offering to the public. Bilingual (English-French) accompanied by summaries in Spanish and Russian.

Annual subscription: $7.00; 35/-; 24.00 F
Each number: $2.00; 10/-; 7.00 F

The International Journal of Adult and Youth Education is a quarterly technical journal intended mainly for specialists in fundamental and adult education. Its articles describe important activities in this field and it publishes information concerning programmes and general lines of policy.

Annual subscription: $1.75; 9/-; 6.50 F
Each number: $0.50; 3/-; 2.00 F



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Order from any bookseller, or write direct to the National Distributor in your country. (See list *below*; *names of distributors in countries not* listed will be supplied on request.) Payment is made in the national currency; the rates quoted are for an annual subscription to THE UNESCO COURIER in any one language.

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